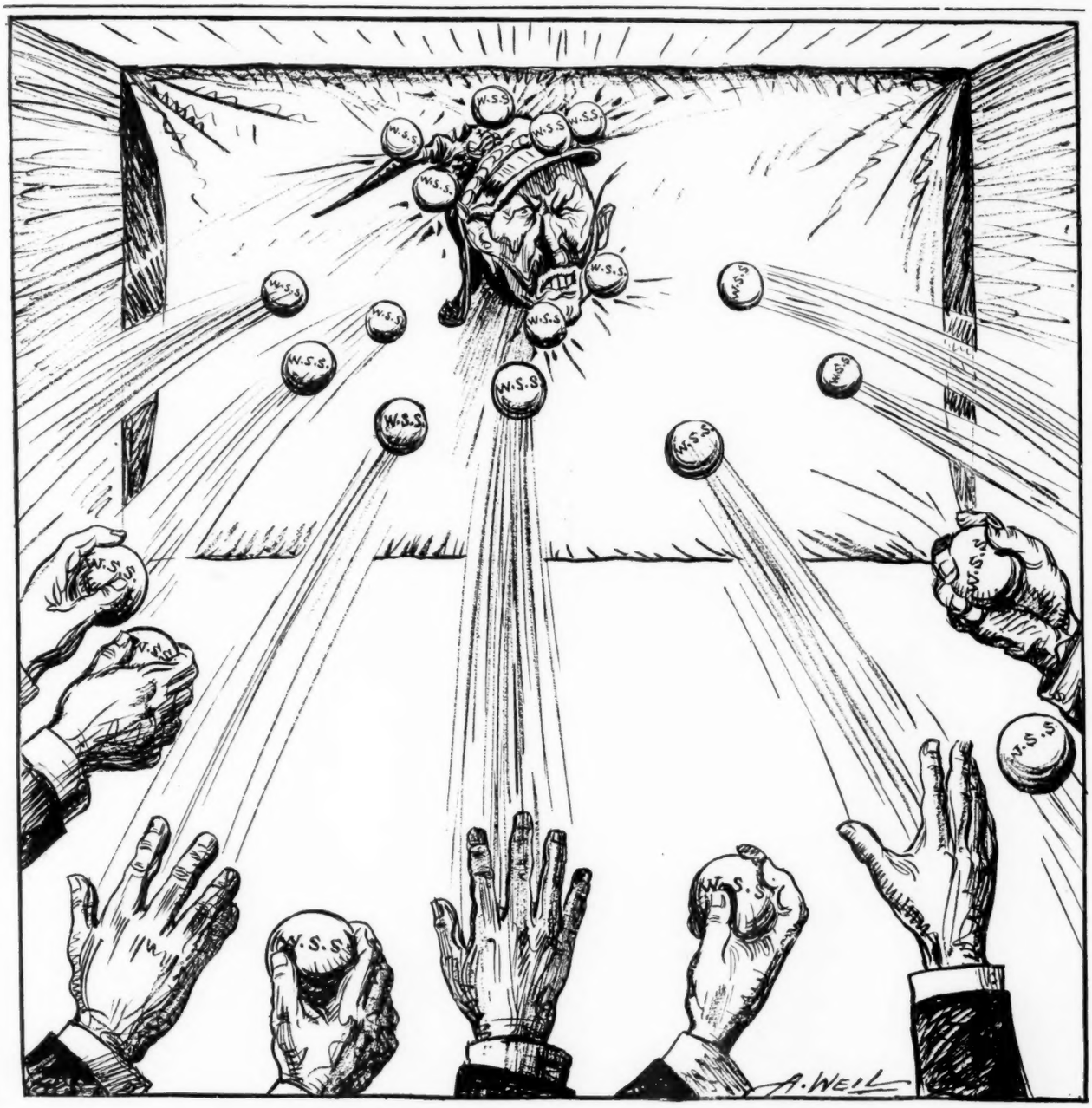
POWER

Volume 48 New York, July 9, 1918 *Number* 2



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Power-Station Earth Connections

By P. H. ADAMS
Assistant Engineer, Public Service Electric Company, Newark, N. J.

The proper method of putting down earth connections for electrical equipment is discussed. Attention is called to the effect of corrosion in power-plant equipment when the proper attention is not given to maintaining the earth connection at a low resistance.

POWER stations as we know them today are more efficient in design and in operation than it was thought possible to make them fifteen years ago. The steam turbine was just making its commercial appearance at that time, and we were still struggling

FIG. 1. ACTION OF ELECTROLYSIS ON PUMP IMPELLER

to get the steam consumption per killowatt-hour below 20 pounds. Since that time steam-driven electrical generating stations have been improved until today these plants rank with the hydro-electric power station on an almost equal basis as to production cost. This rapid progress toward efficiency has been brought about by a strict attention to details in all the parts which go to make up the modern power plant.

One of these details, which has often been allowed to go until after the station was put into service and is then only half done, is the matter of proper earth connection. The word "earth" is used as distinctive from ground, since almost every electric circuit is grounded in varying degrees, but only those permanently and positively connected to an earthing device may be termed earthed.

The negative return on a trolley system has often been considered a sufficient earth connection, and the station superintendent may have wondered why his condenser tubes were corroding so rapidly or why big holes appeared in the propeller wheels of centrifugal pumps. Electrolysis may have been the cause, as was the case in Figs. 1 and 2. Poor rail bonding or insufficient negative-return cables may cause the direct current to take the path of least resistance through the earth to the station and then through the condenser connection to the building frame and the negative bus. The damage done, while not dangerous, caused the tube renewal to more than double in a very short space of time and necessitated a new pump propeller as well. This instance is mentioned in order to emphasize the distinction between the terms earth and ground.

The station structure should be thoroughly earthed and should not have any direct-current circuits connected to it, especially if that circuit feeds apparatus, railway or any other kind, located outside of the station.

The lower part of the steel structure of a power station should be connected together in such a way as

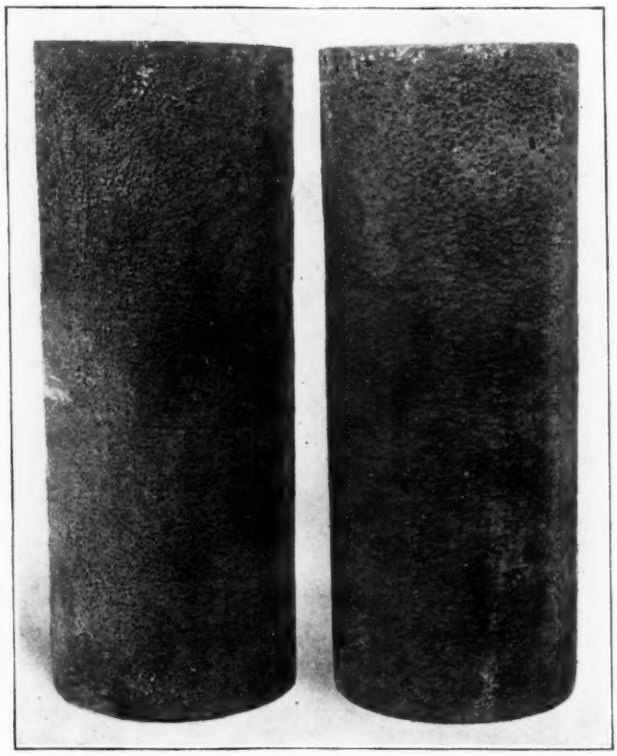


FIG. 2. ACTION OF ELECTROLYSIS ON CONDENSER TUBES

to make an uninterrupted path for stray current to flow, and at frequent intervals positive connection must be made to earth in order that these stray currents may be discharged without damage to the apparatus. The steel superstructure, when entirely framed together, may be passed over with comparatively little bonding except at the switchhouse or where direct current is used to drive auxiliaries. The steel framework of that part of the building used for a switchhouse should be earthed with particular care, and in no case should a single earth connection be relied upon.

The question immediately arises, How can we obtain an earth connection that is positive and yet easy to maintain? There are several types of earth connections such as, (a) copper plate buried in charcoal, (b) station water mains, (c) copper plate buried in mud of a stream and (d) pipe earths.

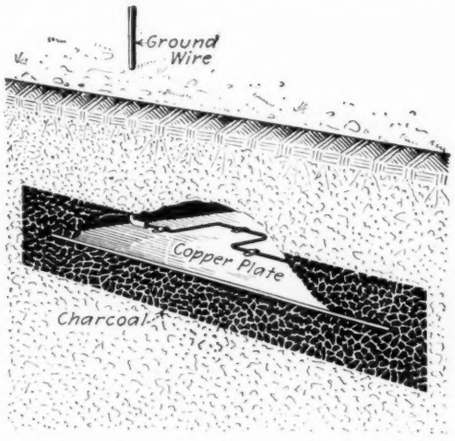


FIG. 3. COPPER-PLATE EARTH CONNECTION

a. This is probably the oldest method of obtaining an earth connection and consists of a copper plate four to six feet square with one or more cables riveted and bonded to it. A hole about eight feet deep is then dug and a 6-in. layer of clean charcoal or broken arc-lamp carbon put in the hole and tamped down with a quantity of water. The copper plate is then laid in the hole and another layer of charcoal placed on top of it and the hole filled with topsoil or a mixture of topsoil or clay and gravel, as shown in Fig. 3. The cables from the plate are then connected to the station's earth bus. The London County Council, London, England, allows the use of copper plates, three feet square, with triangular openings, Fig. 4. This gives somewhat better contact and the holes allow moisture to reach both sides of the plate more directly, nevertheless this method is expensive and at best is erratic in its action.

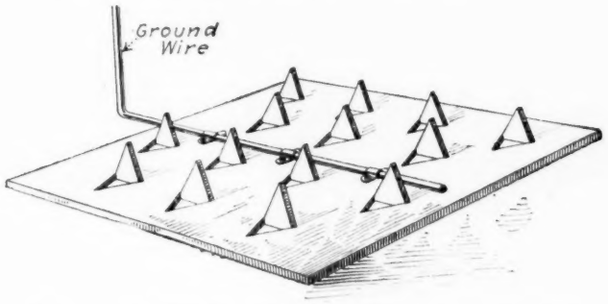


FIG. 4. COPPER-PLATE EARTH CONNECTION WITH TRIANGULAR OPENINGS

b. The use of the water-main connection gives a low-resistance earth, but should be used with care. Several instances are known where more or less damage has been done by heavy currents, discharging to earth by way of the water main, burning holes in the pipes and causing serious leakage in the station, due to an improper joint or to insufficient current-carrying capacity.

c. If the station is convenient to a stream (substations included), a good earth may be obtained by burying a copper plate to a depth of a foot or more in the mud of the stream's bed.

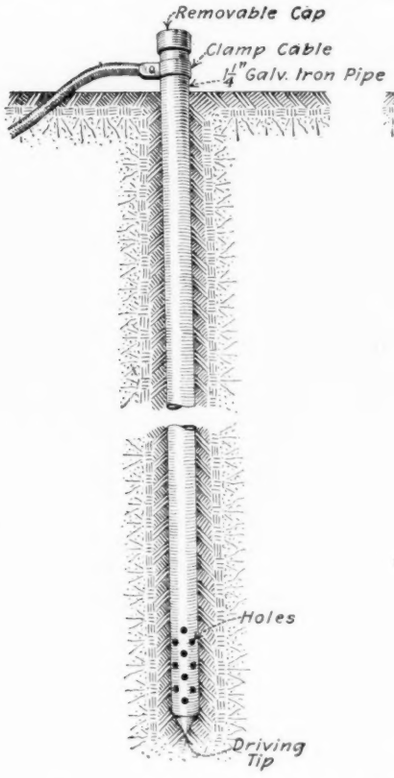


FIG. 5. SHOWING THE SIMPLEST FORM OF PIPE EARTH CONNECTION

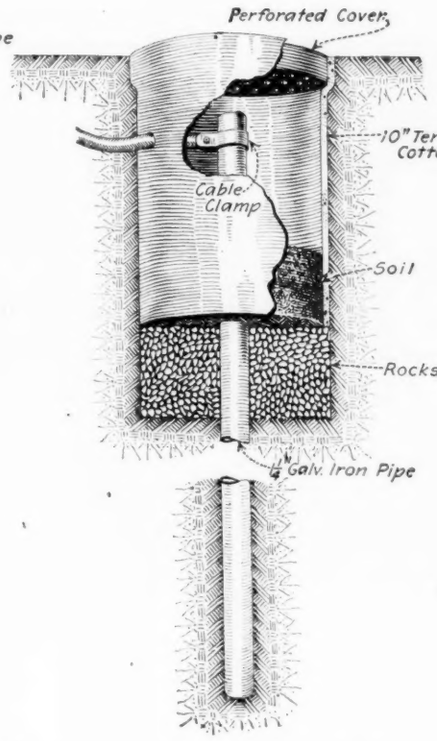


FIG. 6. PIPE EARTH CONNECTION WITH ROCK SALT AROUND TOP END

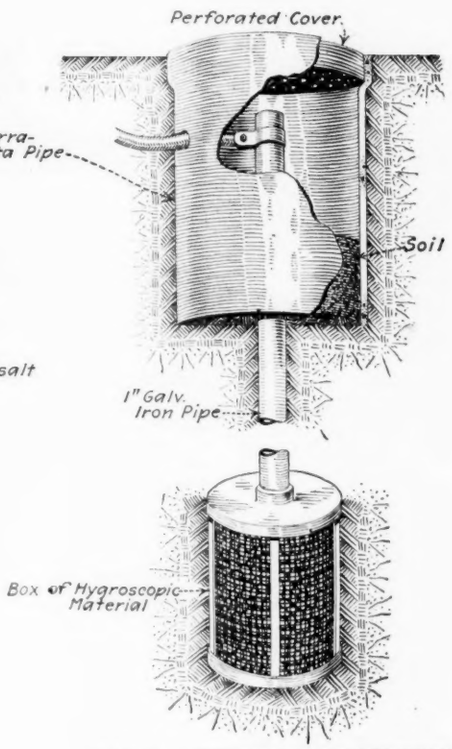


FIG. 7. PIPE EARTH CONNECTION WITH HYGROSCOPIC MATERIAL AT BASE

d. The pipe earth connection is perhaps the simplest, cheapest and most easily maintained of all earth connections and, everything considered, the most satisfactory. It consists of a piece of galvanized-iron pipe, from 1 to 2 in. in diameter and 6 to 8 ft. long, driven into the earth. The upper end is then connected to the station's earth bus by means of a suitable clamp. Figs. 5, 6 and 7 illustrate various types of pipe earth connection.

Fig. 5 is the simplest form of a pipe earth, consisting of a piece of 1¼-in. galvanized-iron pipe 8 ft. long, with a driving point on one end and a screw cap on the other. A dozen or more holes should be drilled through the pipe at the lower end. After driving in place, the pipe should be filled with a saturated solution of salt and water and the screw cap put on. The pipe should be filled with this salt solution as often as is necessary in order to maintain a low-resistance earth. Once a year is usually often enough.

Fig. 6 shows another excellent form of pipe earth connection. This consists of a length of 1¼-in. galvanized-iron pipe driven to a depth of about 8 ft. The earth around the pipe is then removed for a depth of about 2 ft., the diameter of this hole being from 12 to 15 in. Place 25 lb. of coarse or rock salt in the hole, mix in enough topsoil to fill the voids and tamp it down; set a 10- or 12-in. piece of terra-cotta pipe, with a hole in one side for the earth cable to pass through, and then fill with soil and tamp down to within 8 in. of the top of the pipe. The earth cable is then connected as shown by means of a pipe clamp and a perforated iron cover placed over the top of the pipe. Two or three buckets of water poured in when the job is complete will insure good contact. After that rainwater will supply sufficient moisture unless the season is unusually dry. This type of earth connection will last several years without removal. All earth connections should be made outside of the power plant, as this will insure a greater reliability of maintaining a low resistance.

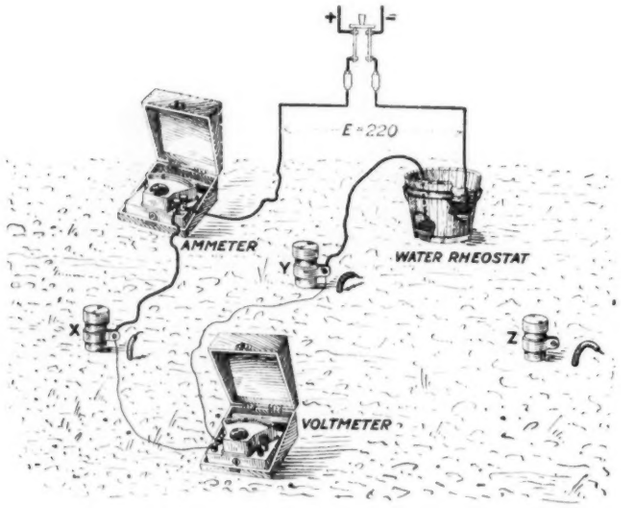


FIG. 8. METHOD OF MAKING EARTH-CONNECTION RESISTANCE TESTS

Fig. 7 is similar to Fig. 6 except that the salt has been replaced by a metal box filled with a hygroscopic material. The hygroscopic material is a patented substance that is supplied by the manufacturer of earthing boxes or cones. The use of these boxes or cones necessitates the digging of a hole 7 to 8 ft. deep, and large enough to receive the box. This type of earth connection is therefore considerably more expensive than that in Fig. 6. It is also sometimes necessary to add a portion of salt to this earth connection in the same way as that in Fig. 6.

The pipe earth is simple, inexpensive, efficient and convenient. It may be installed near the apparatus or building for which it is to be used, and provided a minimum of 6 ft. between centers is maintained, as many as are necessary may be installed and connected in multiple or connected individually to different parts of the building or different pieces of apparatus.

In testing to find the resistance of earth connection, alternating current seems to give the most uniform results. With a voltmeter and an ammeter, a resistance box and a 110- or 220-volt source of current, of 10 to 20 amperes capacity, the resistance of earths X, Y and Z may be found as follows:

The source of power used to make the test must be insulated from the earth and at least three independent earth connections must be available, one of which may be the water system. Connections to make the test are shown in Fig. 8, and readings are taken from X to Y, Y to Z and X to Z. The most convenient form of rheostat for the work is usually a water bucket. In the tests assume readings are obtained as follows: X to Y, amperes $I_x = 10$, volts $E_x = 190$; Y to Z, amperes $I_y = 5$, volts $E_y = 145$; and X to Z, amperes $I_z = 5$, volts $E_z = 135$. In each case the readings are for two earth connections in series; then (1) the resistance on $X + Y = R_x = \frac{E_x}{I_x} = \frac{190}{10} = 19$ ohms, (2) $Y + Z = R_y = \frac{E_y}{I_y} = \frac{145}{5} = 29$ ohms, and (3) $X + Z = R_z = \frac{E_z}{I_z} = \frac{135}{5} = 27$ ohms.

	(3) $X + Z = 27$
Subtracting (1) from (3)	(1) $X + Y = 19$
The result is	(4) $Z - Y = 8$
	(4) $Z - Y = 8$
Adding (2) and (4)	(2) $Y + Z = 29$
Gives	$2Z = 37$
From which	$Z = 18.5$ ohms
$X + Z = 27$	$X = 27 - 18.5 = 8.5$ ohms
$Y + Z = 29$	$Y = 29 - 18.5 = 10.5$ ohms

That is, the resistance of $X = 8.5$ ohms, $Y = 10.5$ ohms and $Z = 18.5$ ohms. The resistance of a good earth connection should not exceed 10 or 15 ohms, although this will vary considerably with soil conditions.

In an early issue the details of earthing apparatus will be discussed and reasons for making earth connections to transformer secondaries and frame of certain parts of station equipment will be given.

Comparative evaporation of coal, oil and gas, according to the United States Geological Survey, is as follows: Under favorable conditions 1 lb. of oil will evaporate from 14 to 16 lb. of water from and at 212 deg., 1 lb. of coal will evaporate from 7 to 10 lb., and 1 lb. of natural gas will evaporate from 18 to 20 pounds.

Some Causes of Boiler-Tube Failures

By R. CEDERBLOM

The author believes that much of the trouble experienced with boiler tubes that blister and fail is due to steam formation in the tube preventing the water from sweeping the tube surface and keeping it cool. He tells how to minimize the trouble and shows the influence of tube baffling upon the steam generated per square foot of tube. It is his opinion that boilers so designed as to give forced water circulation and high gas speed in narrow passages, with evaporation rates of 40 to 50 lb. of water per square foot of heating surface per hour, are needed.

LOOKING at a blistered tube, stretched in the damaged region until it is thin as a knife edge at the point where it opened up, it needs no expert to tell that overheating of the metal was the prime cause of the failure. Frequently, this overheating is erroneously laid to scale or greasy matter introduced with the feed water. If this is always the case, why is it that return-tubular boilers, often working under more trying conditions, give so little trouble of this kind? In this type of boiler we expect overheating on account of the thick shell and heavy riveted joints exposed to the fire, and therefore limit the size and corresponding thickness of these shells to lessen the risk; still comparatively little trouble is experienced from burned sheets even where boilers are allowed to accumulate large quantities of scale and mud between washing-out periods.

On the other hand, if one examines the discarded tubes in the scrap pile back of boiler houses having

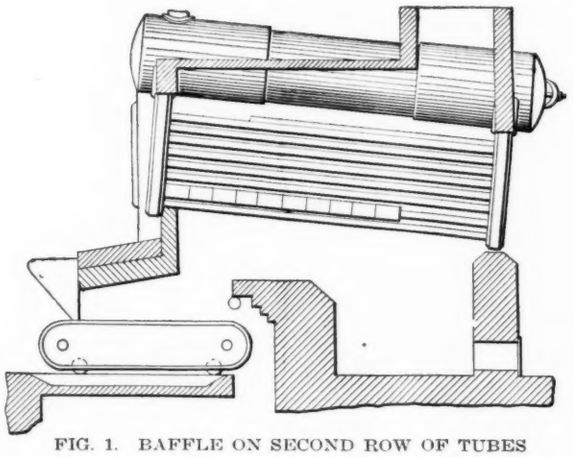


FIG. 1. BAFFLE ON SECOND ROW OF TUBES

frequent troubles with blistered tubes, one finds, as a rule, very slight deposits of scale. Tube renewals in those plants are regarded as a necessary evil. When investigating such cases, it may often be found that in some near-by plant using the same type of boilers, often under much heavier load, using the same kind of feed water, they run along year after year without bursting-tube troubles. With such difference in the performance of the same type of boiler, exposed to the same furnace temperature and given the same care and attention, there must be a decided reason for such unequal results.

To illustrate: One plant consists of two 400-hp. boilers of the type and setting shown in Figs. 1 and 2. These boilers are given the same care and are doing the same amount of work; that is, while one is in operation the other is shut down for cleaning and vice versa. No. 1 has the lower baffle placed on the second row of tubes, as shown, while No. 2 has encircling or C tiles on the lowest row. No. 1 has had a number of tubes re-

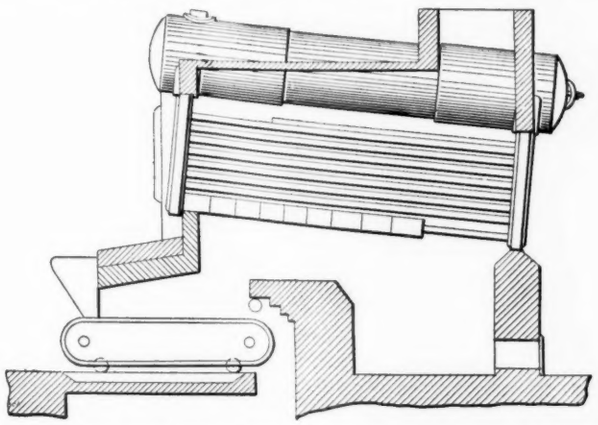


FIG. 2. ENCIRCLING C TILE ON BOTTOM ROW OF TUBES

newed in the lowest row at different times, while no trouble in this respect has been experienced so far in the four years No. 2 has been in service. The trouble with No. 1 consists in blisters on the under side of tubes in the region over the grate and bridge-wall. Another plant has four boilers of the same type, originally baffled the same as shown in Fig. 2. These boilers were subject to hard service for a number of years without sign of tube failures; but on account of unusually high uptake temperature when forced above rating, the baffles in three of them were changed in the manner shown in Fig. 3. The change increased the efficiency, as expected, by lowering the temperature of the waste gases, but in a short time all three boilers developed blisters in the lowest row of tubes in a region two to four feet from the front header. After several tubes had been renewed, it was decided to restore the original baffling, after which no further trouble was experienced. In another plant with three boilers of a different make but of the same type, the boiler-room force was kept busy most every Sunday replacing blistered tubes until a device for increasing the circulation was installed, which overcame the trouble. In every case referred to, the boilers were given the best of care and kept cleaner than the average.

If a piece of boiler tube is placed in a blacksmith fire, it takes quite a few minutes to bring the metal up to red heat, but only a second to cool it off by plunging the piece in a bucket of water. This proves beyond doubt, that if the damaged tube had been swept by a body of water at least every second or two, no overheating could have taken place and, vice versa, that the

spots where overheating occurred have been without contact with water for considerably longer periods. The experiment also proves that where water is in contact with the metal, it can absorb the heat many times faster than the heat can be applied to the tube, no matter to what rate the fires are forced or the furnace temperature raised.

As investigation shows that practically clean tubes are blistered as described as readily as those considerably scaled, the logical conclusion is that the steam formed in the tube, or rather the quantity of steam formed there, is responsible for the overheating. In other words, the individual tube will stand, under certain conditions, only a certain load and no more, and after the critical point is reached it breaks down no matter if conditions as to cleanliness and quality of material are the best. In the same type of boilers this critical point is reached sooner in one case than in another, because the furnace construction and baffling are such as to subject a small part of the heating surface to a larger percentage of the load in one case than in the other, instead of a more equal heat distribution throughout the entire heating surface of the boiler.

After the boiling point and maximum water temperature are reached, the circulation in any boiler is the result of steam formation. In the water-tube type circulation is maintained by the steam formed in the individual tube and, with ideal construction based on the U-tube principle and neglecting friction, would increase with the amount of steam generated, the velocity equal to $v\sqrt{2gH}$, where H is the head measured in terms of the steam-water mixture. As ordinarily constructed, however, this is far from being the case. Considering, for example, the design and setting, Fig. 2, one finds from experiments carried out by the technological branch of the United States Geological Survey, Bulletin 23, "Steaming Tests of Coal," that this circulation is greatest in the lowest row of tubes, as one would naturally

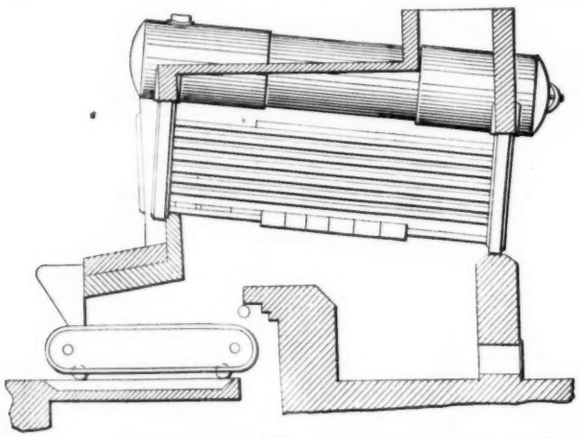


FIG. 3. A SLIGHT IMPROVEMENT OVER FIGS. 1 AND 2

expect, decreasing rapidly with each successive row above, the top rows showing hardly any circulation. It also shows the important fact that, although the velocity increases with the load, it is not in proportion to the steam made; and after a certain point is reached, this velocity rapidly drops away behind the amount of steam generated at high ratings. At these experiments the readings were taken from the middle tube of the lowest row, the middle tube of the third row from the bottom, and the third row from the top. While the circulation at 92.2 per cent. rating was 291 ft. per min. in this lowest row, it dropped to 273 ft. at 118.2 per cent. rating, considerably less than at a lighter load; whereas, to be proportional to the capacity, it should have indicated 363 ft. per min. If the experiment had been carried further to apply to a setting as shown in Fig. 1, I do not doubt that poor circulation in the lowest row of tubes would have been shown at high ratings.

Referring to Fig. 2, the lowest rows of tubes are in-

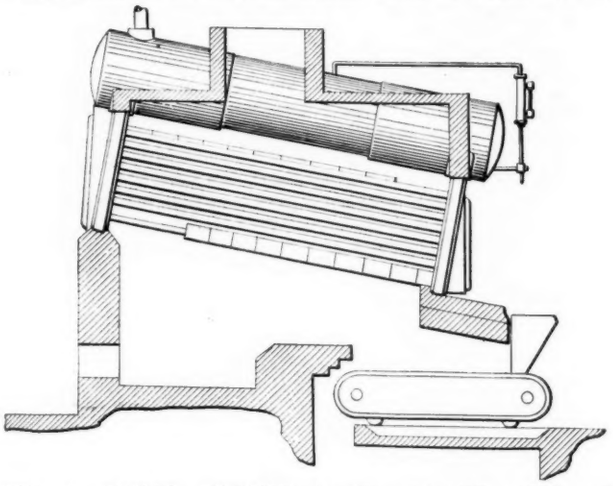


FIG. 4. BOILER PITCHED 36 IN. TO THE FOOT TO IMPROVE CIRCULATION

closed in loose-fitting tiles, the space between the tiles and tubes being packed with fine soot and ashes after the boiler has been in operation for some time. That this covering constitutes a fairly good insulation against heat transmission is proved by the short life of these tiles at high furnace temperature; nevertheless with this construction the lowest rows of tubes, although directly exposed for only one-fourth of their length to the hot gases and radiant heat from the furnace walls, generate about 25 per cent. of all the steam made by the boiler, which in a 400-hp. unit would be 3450 lb. per hour, or 181.5 lb. per hour per tube in a boiler of 19-tube width, equal to a heat absorption of about 176,000 B.t.u. per hour. Most of this heat is no doubt absorbed by the four or five feet of exposed tube in the rear end, as the rest of the tube is subject only to heat imparted by conduction through the tile and soot, which is a comparatively small amount as there is no decided drop in the temperature of the gases until they have passed the opening between these rows of tubes in the rear end. If the boiler is working at about 100 lb. gage pressure, this means that 345 cu.in. of steam is generated in one of these tubes every second, or enough to fill a 4-in. tube for a length of 31 inches.

If the C tile is replaced with T tile, the baffle is placed on the second row of tubes as shown in Fig. 1, exposing the lowest row to direct radiation from the fire bed, furnace walls and bridge-wall, and each tube will have at least six additional square feet subject to radiated heat alone, amounting to not less than 100,000 B.t.u. per sq.ft. at average furnace temperature, in addition to the heat transmitted by convection. When tubes are in direct contact with the gases it puts an additional load of four to five times the original on these tubes, provided the circulation is such as to absorb this heat with-

out raising the temperature of the metal sufficiently to generate steam enough to nearly fill the 4-in. tube every second. But this would mean that the 19 tubes alone would be developing, theoretically, the full load of the boiler working at 125 per cent. rating. That such is not the case we know from temperature readings taken between the upper tubes.

They do, however, develop from 40 to 50 per cent. at times, but with decreasing circulation under such high rating there is a rapid falling off in heat absorption, the principal reason being that, owing to the very construction of the boiler, the water is not always there to absorb the available heat, resulting in an increase of temperature of the metal which in turn reduces the rate of heat transfer, as the latter depends on the difference in temperature between the hot and the cold bodies.

Slight Difference in Hydrostatic Head

It is my opinion that, because of the comparatively large front water-leg, the density of the liquid in it is nearly the same as in the rear leg, and therefore there is only a slight difference in hydrostatic head between the two, the steam entering the front leg slipping up through the water without much pumping action on the water in this leg, with the result that the circulation in the individual tubes is almost entirely depending upon the steam formation in the respective tubes, and is not appreciably accelerated by any general circulation through the boiler as a whole. With the slight inclination of the tubes—1 in. to the foot seems to be the adopted standard for this type—the resistance to quick release of large quantities of steam formed in one of these tubes is nearly as great toward one leg as to the other, with the result, I believe, that the whole tube is at times filled with steam under a slightly greater pressure than that existing in the legs before the resistance is overcome, stopping the circulation for a time and often forcing the steam to leave the tube in both directions. In the meantime the temperature of the metal is raised considerably, and by the time solid water has again managed to enter the rear end of the tube and start toward the front water-leg, it reaches this end, if at all, as a more or less frothy mixture, which may not have much cooling effect on the overheated region at the front end of tube. A continuation of such a process will finally result in some part of the tube reaching a temperature where the reduced tensile strength is no longer sufficient to withstand the pressure, the metal stretches, and finally opens up. When one considers that experiments with 3½-in. boiler tubes have shown that they will stand an internal pressure of 200 lb. per sq.in. while being heated to 2000 deg. F. without stretching more than $\frac{3}{32}$ in. in excess of the original diameter, one gets an idea of to what severe conditions the tube must have been subjected, or how poor the circulation must have become, before the tube ruptured or became blistered. A greater pitch, even with the ordinary construction, would greatly improve the circulation and give better protection.

Where a boiler is already installed, other means must be adopted to stop the trouble, and the box tile applied as shown in Fig. 2 is one of the remedies for this particular type, although it cuts down the efficiency of the boiler to some extent. If furnace construction is such as to allow of changing from a horizontal to a vertical baffle, this will also serve the same purpose while maintaining the efficiency. With a vertical baffle there is a more uniform distribution of the heat among the tubes, and the region where most of the steam is generated is nearest the front leg, giving quick release of the steam made and less chance for steam pockets to form or possibilities of reversal of circulation. With hand-fired furnaces flush with the boiler front, a vertical baffle is often objectionable because it tends to produce smoky combustion; but unless the setting is very low, this can be overcome by smoke-consuming arrangements.

Horizontal Baffle Easy To Clean and Repair

When installing a new boiler of the type referred to, those who prefer a horizontal baffle—and it has its advantages in regard to cleaning and repair—would do well to consider a reversal of the usual practice and place the furnace under the lower end of the boiler and give the boiler all the pitch possible. The writer would not hesitate to go as far as shown in Fig. 4. With this arrangement one would have a tube pitch of 36 in. instead of 18 in., which would theoretically nearly double the circulation in the individual tube, and actually no doubt give at least a positive circulation sufficient to insure the tube against overheating. The usual baffle plate over the passage into the steam drum, which now only adds to the resistance of the upflowing mixture of steam and water, would be discarded entirely in such a case to give uninterrupted flow, moisture to be taken care of by another snug-fitting deflecting plate well above the water line. With this setting there would be a much more uniform distribution of heat and load among the upper tubes. The hottest gases would be applied to the proper place, the highest end of the tubes and the front leg, and as they cool they give up what heat is left to the coolest part of the boiler, which contains only solid water.

In the B. & W. type there is a greater pitch than in the type of boiler discussed. With the sectional front header of small area there also is a decided difference in density and hydrostatic head, which should give excellent circulation if it was not seriously cut down by the restricted area of the nipples entering the drum, a resistance sufficient to shorten the life of the tubes even in this type, at very high ratings, especially if the heat is concentrated into a small area, as for instance when using oil burners.

It is interesting to mention the experiments by H. S. Markey described in a paper read before California No. 3, N. A. S. E., Apr. 24, 1912. Having had considerable trouble with blistered and burned tubes in 12 B. & W. type water-tube boilers (oil-fired) on account of heavy peak loads, and in spite of the utmost precaution against scale or other impurities that might cause overheating, Mr. Markey concluded that insufficient circulation was the underlying cause of the trouble. To overcome this he bushed down the front ends of the upper tubes where they entered the headers, to insure sufficient flow to the bottom tubes. To further increase the circulation by increasing the hydrostatic head, he continued the passages from the connecting nipples up to the water level in the front end of the steam drum with light sheet-iron pipes. After this was done, the trouble ceased, although the boilers so equipped were subjected to combustion rates limited only by the available draft.

A device accomplishing the same results has since been patented and put on the market—the Broman Circulating Device—and according to claims is applicable to any type of water-tube boiler.

That there will be a radical departure from the ordinary design of boilers in the near future is the writer's opinion—a design based pricipally on rapid circulation, either mechanically forced or due to steam formation, and capable of generating from 40 to 50 lb. of steam per square foot of heating surface instead of the present apparatus, which develops about 70 per cent. of the power from one-third of the heating surface and requires two-thirds of the remaining surface to absorb what little is left of the available heat. High gas speed in narrow passages, and tubes of small diameter, at least in the last passes, in connection with high velocity of the liquid inside of the tubes, will probably be the main features of these boilers, and heat transmission under such conditions will be so rapid that troublesome systems of baffling will no longer be necessary.

Tube failures are of considerable importance to engineers, manufacturers and insurance companies, and should be thoroughly discussed in such publications as *Power*, as the trouble can no doubt be minimized if given more attention.

To reduce the number of killed, wounded and infected in the permanent, everlasting struggle of man with the forces of nature is the object of the National Safety Council. Death, injury and incapacity due to preventable accidents and avoidable industrial diseases have been a drag upon industrial efficiency and a burden to the common weal the extent of which has only begun to be appreciated. The Council has issued a pamphlet urging the teaching of safety in technical schools and universities, which will be read with interest by all who are concerned with such work. Copies may be had by applying to W. H. Cameron, General Manager, National Safety Council, Continental and Commercial Bank Building, Chicago; A. H. Young, director, American Museum of Safety, 14 West 24th St., New York, or Albert W. Whitney, Chairman Safety Education Committee of the National Safety Council, 13 Park Row, New York.

Table of B. T. U.'s Per Boiler Horsepower at Various Efficiencies

BY CHARLES H. BROMLEY

With the increasing attention to boiler and furnace performance the B.t.u. equivalent of the boiler-horsepower, or

$$970.4 \times 34.5 = 33{,}479 \text{ B.t.u.}$$

becomes more generally used. The reader recognizes, of course, that the factor 970.4 is the latent heat of vaporization per pound of water from and at 212 deg. F., and that 34.5 is the number of pounds of water evaporated per hour from and at 212 deg. F. per boiler-horsepower.

The table herewith gives the B.t.u. equivalent per boiler-horsepower for various combined boiler and furnace efficiencies ranging from the woeful 40 per cent. to the yet commercially distant 89 per cent.

HEAT UNITS IN B.T.U. PER BOILER HORSEPOWER AT VARIOUS COMBINED BOILER AND FURNACE EFFICIENCIES

Combined Boiler and Furnace Efficiency, Per Cent.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	Heat Units, B. T. U.									
89	37,161.69	37,128.21	37,094.73	37,061.25	37,027.78	36,994.30	36,960.82	36,927.34	36,893.86	36,860.38
88	37,496.48	37,463.00	37,429.52	37,396.24	37,362.56	37,329.09	37,295.61	37,262.13	37,228.65	37,195.17
87	37,831.27	37,797.79	37,764.31	37,730.83	37,697.35	37,663.87	37,630.40	37,596.92	37,563.44	37,529.96
86	38,166.06	38,132.58	38,099.10	38,065.62	38,032.14	37,998.66	37,965.19	37,931.71	37,898.23	37,864.75
85	38,500.85	38,467.37	38,433.89	38,400.41	38,366.93	38,333.45	38,299.98	38,266.50	38,233.02	38,199.54
84	38,835.64	38,802.16	38,768.68	38,735.20	38,701.72	38,668.25	38,634.77	38,601.29	38,567.81	38,534.33
83	39,170.43	39,136.95	39,103.47	39,069.99	39,036.51	39,003.04	38,969.56	38,936.08	38,902.60	38,869.12
82	39,505.22	39,471.74	39,438.26	39,404.78	39,371.30	39,337.83	39,304.35	39,270.87	39,237.39	39,203.91
81	39,840.01	39,806.53	39,773.05	39,739.57	39,706.09	39,672.62	39,639.14	39,605.66	39,572.18	39,538.70
80	40,174.80	40,141.32	40,107.84	40,074.36	40,040.88	40,007.40	39,973.92	39,940.04	39,906.97	39,873.49
79	40,509.59	40,476.11	40,442.63	40,409.15	40,375.67	40,342.19	40,308.72	40,275.24	40,241.76	40,208.28
78	40,844.38	40,810.09	40,777.42	40,743.94	40,710.46	40,676.98	40,643.51	40,610.03	40,576.55	40,543.07
77	41,179.17	41,145.69	41,112.21	41,078.73	41,045.25	41,011.77	40,978.29	40,944.82	40,911.34	40,877.85
76	41,513.96	41,480.48	41,447.00	41,413.52	41,380.04	41,346.56	41,313.09	41,279.61	41,246.13	41,212.65
75	41,848.75	41,815.27	41,781.80	41,748.31	41,714.83	41,681.36	41,647.88	41,614.39	41,580.91	41,547.44
74	42,183.54	42,150.06	42,116.58	42,083.10	42,049.62	42,016.14	41,982.67	41,949.19	41,915.71	41,882.23
73	42,518.33	42,484.85	42,451.37	42,417.89	42,384.41	42,350.93	42,317.46	42,283.98	42,250.50	42,217.02
72	42,853.12	42,819.64	42,786.16	42,752.68	42,719.20	42,685.72	42,652.25	42,618.77	42,585.29	42,551.81
71	43,187.91	43,154.43	43,120.95	43,087.87	43,053.99	43,020.52	42,987.04	42,953.56	42,920.08	42,886.59
70	43,522.70	43,489.22	43,455.74	43,422.26	43,388.78	43,355.31	43,321.83	43,288.35	43,254.87	43,221.39
69	43,857.49	43,824.01	43,790.53	43,757.05	43,723.57	43,690.09	43,656.52	43,623.14	43,589.66	43,556.18
68	44,192.28	44,158.80	44,125.32	44,091.84	44,058.36	44,024.88	43,991.40	43,957.93	43,924.45	43,890.96
67	44,527.07	44,493.59	44,460.11	44,426.63	44,393.15	44,359.67	44,326.20	44,292.72	44,259.24	44,225.76
66	44,861.86	44,828.38	44,794.90	44,761.42	44,727.94	44,694.46	44,660.99	44,627.51	44,594.03	44,560.55
65	45,196.65	45,163.17	45,129.70	45,096.21	45,062.73	45,029.25	44,995.78	44,962.29	44,928.82	44,895.34
64	45,531.44	45,497.96	45,464.48	45,431.00	45,397.52	45,364.05	45,330.57	45,297.09	45,253.61	45,230.13
63	45,866.23	45,832.75	45,799.27	45,765.79	45,732.31	45,698.84	45,665.36	45,631.88	45,598.40	45,564.92
62	46,201.02	46,167.54	46,134.06	46,100.58	46,067.10	46,033.63	46,000.15	45,966.67	45,933.19	45,899.71
61	46,535.81	46,502.33	46,468.85	46,435.37	46,401.89	46,368.42	46,334.94	46,301.46	46,267.98	46,234.50
60	46,870.60	46,837.12	46,803.64	46,770.16	46,736.68	46,703.21	46,669.73	46,636.24	46,602.77	46,569.29
59	47,205.39	47,171.91	47,138.43	47,104.95	47,071.47	47,037.99	47,004.52	46,971.04	46,937.56	46,904.08
58	47,540.18	47,506.70	47,473.22	47,439.74	47,406.26	47,372.78	47,339.31	47,305.83	47,272.35	47,238.87
57	47,874.97	47,841.49	47,808.01	47,774.53	47,741.05	47,707.57	47,674.10	47,640.62	47,607.14	47,573.66
56	48,209.76	48,176.28	48,142.80	48,109.32	48,075.84	48,042.37	48,008.88	47,975.41	47,941.92	47,908.45
55	48,544.55	48,511.07	48,477.59	48,444.11	48,410.63	48,377.15	48,343.68	48,310.20	48,276.72	48,243.23
54	48,879.34	48,845.86	48,812.38	48,778.90	48,745.42	48,711.95	48,678.47	48,644.99	48,611.51	48,578.03
53	49,214.13	49,180.65	49,147.17	49,113.69	49,080.21	49,046.73	49,013.26	48,979.78	48,946.30	48,912.82
52	49,548.92	49,515.44	49,481.96	49,448.48	49,415.00	49,381.52	49,348.05	49,314.57	42,281.09	49,247.61
51	49,883.71	49,850.23	49,816.75	49,783.27	49,749.79	49,716.32	49,682.84	49,649.36	49,615.88	49,582.40
50	50,218.50	50,185.02	50,118.06	50,084.59	50,051.10	50,017.63	49,998.41	49,984.15	49,950.67	49,917.19
49	50,553.29	50,519.81	50,486.33	50,452.85	50,419.37	50,385.90	50,352.42	50,318.94	50,285.46	50,251.97
48	50,888.08	50,854.60	50,821.12	50,787.64	50,754.16	50,720.69	50,687.21	50,653.73	50,620.25	50,586.77
47	51,222.87	51,189.39	51,155.91	51,222.43	51,088.95	51,055.40	51,021.99	50,988.52	50,955.03	50,921.56
46	51,557.66	51,524.18	51,490.70	51,457.22	51,423.74	51,390.26	51,356.79	51,323.31	51,289.83	51,256.35
45	51,892.45	51,858.97	51,825.49	51,792.01	51,758.53	51,725.05	51,691.58	51,658.10	51,624.62	51,591.14
44	52,227.24	52,193.76	52,160.28	52,126.80	52,093.32	52,059.84	52,026.37	51,992.89	51,959.40	51,925.93
43	52,562.03	52,528.55	52,495.07	52,461.59	52,428.11	52,394.63	52,361.16	52,327.68	52,294.20	52,260.72
42	52,896.82	52,863.34	52,829.86	52,796.38	52,762.90	52,729.43	52,695.95	52,662.47	52,628.99	52,595.50
41	53,231.61	53,198.13	53,164.65	53,131.17	53,097.69	53,064.21	53,030.74	52,997.26	52,963.78	52,930.29
40	53,566.40	53,532.92	53,499.44	53,465.96	53,432.48	53,399.00	53,365.53	53,332.05	53,298.57	53,265.09

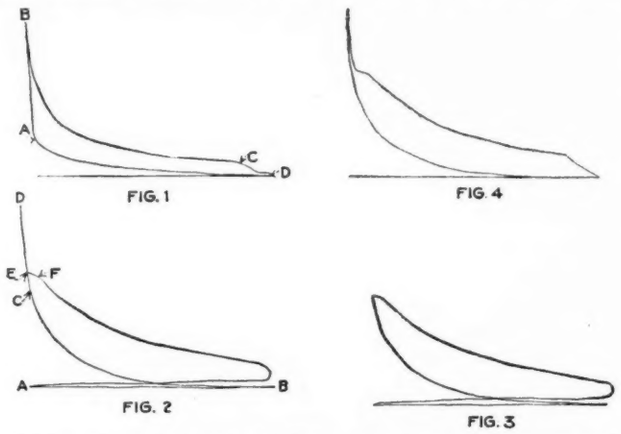
The Semi-Diesel Oil Engine

By L. H. MORRISON

In general appearance, some semi-Diesel engines are similar to low-compression oil engines; but the two types are radically different, not only in theory but in actual operation. So great is the difference that there is no excuse for the confusion that exists in the mind of the average operator.

THE low-compression oil engine is a vaporizing machine, and after the liquid fuel is vaporized, the resulting gaseous charge is exploded as in a gas engine. The low-compression engine receives all the heat of combustion at constant volume, while the piston is in one predetermined position. In other words, the combustion is instantaneous.

The semi-Diesel engine, on the other hand, receives its heat at fairly constant pressure. The piston is moving all the time the fuel is being introduced and burned. If the injection of oil is properly regulated, the fuel will be introduced at such a rate as to allow the resulting cylinder pressure to remain constant while the piston recedes. In practical operation the regulation that usually exists is such as to cause a decided curvature in the combustion line on the indicator card.



FIGS. 1 TO 4. DIAGRAMS FROM TWO- AND FOUR-STROKE CYCLE ENGINES

An indicator card taken from a two-stroke-cycle low-compression engine is shown in Fig. 1. The compression reaches a value of about 100 lb. per sq. in. at the end *A* of the stroke. At this point the gaseous charge is exploded and the maximum explosion pressure reaches 400 lb. per sq. in. at *B*. In this engine all the heat is added along the vertical line *AB*, at constant volume. The expansion line is *BC*, while the burnt gases are expelled from *C* to *D*. The exhaust ports open at the point *C*, causing a very sharp drop in the pressure.

Fig. 2 is a card from a four-stroke-cycle semi-Diesel engine. In this engine a cylinderful of fresh air is sucked in from *A* to *B* and compressed from *B* to *C*. At the point *C* the atomizer explodes a primary charge, raising the pressure to about 600 lb. per sq. in. at *D*, which causes the injection of a secondary fuel charge from *E* to *F*. The secondary charge, which is the main fuel charge, is injected and burned at practically constant pressure. The small primary charge adds but a slight amount of power to the engine, and may be ignored entirely. If the sharp peak from *E* to *D* is eliminated, the card will have the form shown in Fig. 3, which to all appearances is a typical Diesel-engine card.

The card shown in Fig. 4 was taken from a two-stroke-cycle semi-Diesel engine and shows the same effects of the primary and secondary charges. Comparing this with Fig. 1, it is evident that the compression in Fig. 4 is carried much higher and that the addition of heat is accomplished in a vastly different manner from that followed in the low-compression constant-volume engine.

Several makes of semi-Diesel engines use the "cup" form of injection and atomization of the fuel. With this device the combustion of the atomized fuel is accomplished by means of the heat of compression, exactly as in the true Diesel engine. The sectional view in Fig. 5 shows a cup used to cause the injection of the main fuel charge. The operation of this device is based on the fact that every oil, no matter how heavy it may be, contains some light hydrocarbons that will vaporize or distill at a fairly low temperature. The explosion of these lighter parts of the fuel oil is made the means whereby the remainder is injected in a finely atomized condition. It is a further matter of common knowledge that the temperature of ignition of an oil is dependent on the degree of atomization.

Method of Operation of Cup-Type Injector

In Fig. 5 the cup or primary cylinder *A* has ports *B* and *C* that communicate with the outside air at *D* and with the fuel supply at *E*. As the piston *F* starts on its suction stroke, the pressure inside the cup *A* decreases, as the joint between the cup and the cylinder casting is not tight. The reduced pressure in the cup causes a small charge of air and oil to be drawn into the cup. The oil port *G* is closed by the action of the governor, thereby regulating the amount of the fuel charge. At the proper point, at the end of the suction stroke, the cup moves upward and closes the fuel and air ports *B* and *C*, and at the same time covers the communicating port *H* in the side of the cup. As the piston returns on its compression stroke, the air leaking past the joint between the cup and the cylinder raises the pressure in the cup to from 350 to 400 lb. per sq. in. The resulting temperature is sufficient to vaporize and ignite some of the light hydrocarbons, causing a maximum ignition pressure inside the cup of about 700 lb. per sq. in. Just before the crank reaches dead-center, the cup is rotated a slight amount, uncovering the port *H*. The extremely high pressure in the cup immediately forces the heavy oil charge out through the port *H* into the cylinder space. In passing through the port into the low pressure existing in the cylinder, the oil is atomized sufficiently to unite with the air charge in the cylinder.

It will be observed that the character of the oil determines in a great measure the time of ignition and the shape of the combustion line on the indicator card If the oil is extremely heavy, with the lightest hydrocarbons of fairly low gravity, then the light portion will not ignite in the cup until practically dead-center

is reached. The pressure in the cup, due to this primary combustion, will not reach a high value before the port *H* is opened. The pressure difference existing between the cup and the cylinder will not be great, and consequently the injection through the port *H* will be slower and the combustion line on the card will be practically horizontal.

In the card shown in Fig. 1 the oil used was around 26 deg. Baumé and contained a considerable percentage of light oils. The explosion in the cup was consequently intense, causing a high pressure. This high pressure combined with the explosion of the remainder of the lighter percentage of oil as it entered the cylinder was sufficient to cause the peak on the card at dead-center. The heavy particles of oil burned more slowly, as indicated by the sloping combustion line.

In operation much depends on the adjustment of the cup-valve stem. If the movement of the cup uncovers the port *H* too early, preignition will occur. Since the pressure carried is much higher than in the low-compression engine, preignition has a greater detrimental effect. Ordinarily, the bearings show great wear, and they, as well as the shaft, should be made heavier than is customary.

The cup has a tendency to become fouled with carbon and should be inspected regularly. Attention should be paid to the beveled seat between the cup and the engine casting, as the slightest leakage at this point will prevent the engine from operating satisfactorily. The seat may be ground with coarse emery compound, finishing with a mixture of pumice flour and oil. Cylinder oil such as is used on ammonia compressors makes the best paste.

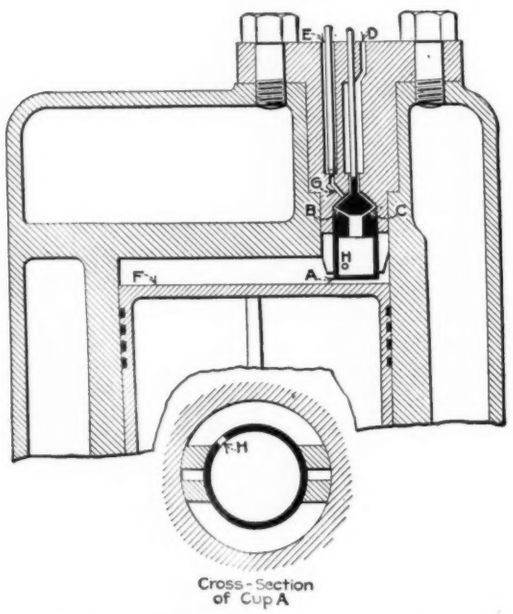


FIG. 5. CUP TYPE OF FUEL INJECTOR

The cup type of fuel injection, when properly adjusted, eliminates preignition trouble, and as a consequence no water need be injected into the cylinder. This lengthens the life of the cylinder and reduces the amount of lubricating oil necessary. As to the latter, 1000 hp.-hr. should be obtained with the use of a gallon of lubricating oil, including the loss in the bearing oil. This statement, of course, is based on the assumption that the bearing oil is filtered and reused.

Another form of cup, used on an engine of the two-stroke-cycle type, is shown in Fig. 6. The fuel oil is injected into the cup *A* through the atomizing nozzle *B* by the action of a pressure pump, not shown, during the compression stroke of the piston. As the compression pressure in the cylinder rises, part of the compressed air is forced through the ports *C* into the cup. It is here mixed with the lighter oils that have been vaporized

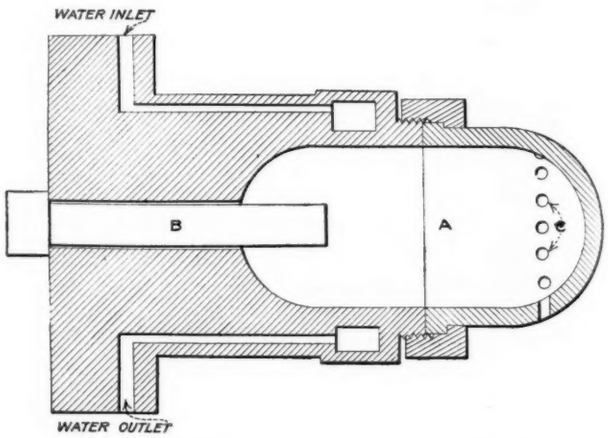


FIG. 6. WATER-JACKETED FUEL INJECTOR

as they passed from the nozzle *B* into the hot cup. As the temperature due to compression reaches a certain value, dependent upon the characteristics of the fuel, ignition of the vaporized light oil occurs. The increased pressure forces the remainder of the oil out through the ports *C* into the cylinder charge of pure air. Here the oil and the air mix and the atomization is sufficient to occasion combustion.

In this device the timing of the injection of the secondary, or main, fuel charge into the cylinder is not under positive control. If the oil is of light gravity, it will ignite in the cup early in the compression stroke and cause the secondary charge to be injected considerably before dead-center. This will cause preignition and pounding that will be especially hard on the piston-pin bearing, which will be hammered out of shape.

To avoid preignition trouble, the cup is partly water-cooled, thus keeping the cup pressure and temperature within limits. Water injection into the cylinder is also used. Since the water control is not automatic, on a varying load the operator should be careful to adjust the water valves. Too many engineers ignore this and wonder at the short life of the bearings. This design, as well as the former cup design, works best on a heavy fuel oil. If water injection is used, care should be taken to see that the oil contains but a small percentage of sulphur.

The third type of semi-Diesel engine uses a combination of the Diesel principle of atomizing the oil by means of a stream of high-pressure air, and the hot bulb similar to that used on a low-compression engine. A cross-section of such an engine is shown in Fig. 7. In general outline and in many of the details it conforms to the horizontal Diesel pattern. It makes use of a two-stage high-pressure air compressor *A* for the supply of injection and starting air. The fuel valve is of a design that could be used on any Diesel with satisfaction.

In operation, the bulb *B*, attached to the side of the combustion chamber, is heated by a kerosene torch. The engine is then turned over by the admission of low-pressure air through the starting valve. The injection pump is thrown into action, and at the proper moment a charge of fuel is blown into the cylinder along with the

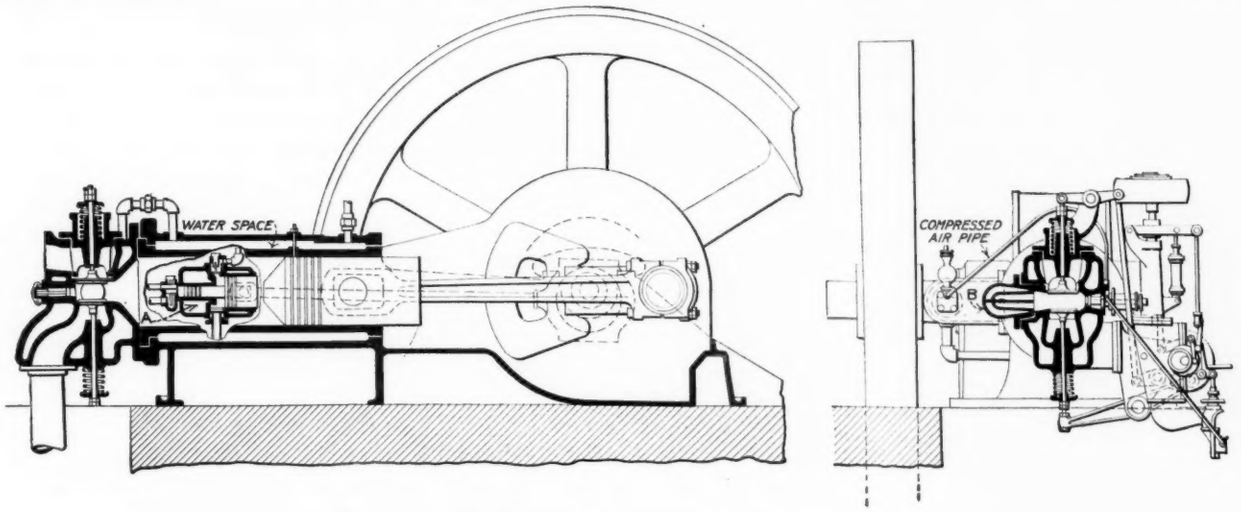


FIG. 7. CROSS-SECTION OF ENGINE USING HOT BULB

charge of high-pressure air. The scheme of operation calls for part of the oil to strike the hot bulb and so ignite. This probably is achieved when the oil has a heavy asphaltum base. At least, when using this type of oil, a heavy asphaltum or carbon deposit usually occurs. On the other hand, if the fuel is above 24 deg. Baumé the compression carried (about 300 lb. per sq. in.) is ample to ignite the fuel when properly atomized. As evidence of this attention is directed to the fact that the hot bulb seldom, if ever, carbonizes with light oils, although the low-compression hot-bulb engine does carbonize with the same oil. From this, one will naturally conclude that but little of the light oil ever reaches the bulb and that a hot bulb is a superfluity with any save the heaviest of oils. At times true Diesel engines have been observed operating with compression pressures as low as 300 to 350 lb. per sq. in., in cases where the piston ring or valves leaked. Under such conditions the engine would ignite each charge, although the combustion would not be perfect, causing a smoky exhaust. After an engine is warmed up, compression to 300 lb. will ignite any of the light-gravity oils.

The engine shown in Fig. 7 gives an indicator card, when light oils are used, quite like that of a Diesel, the admission line being well developed and at practically constant pressure. As a consequence it is to be expected that this type will show a better fuel economy than is shown by the cup atomizing type. In the former 14 hp. per gallon of fuel should be obtained in everyday operation, corresponding to about 0.55 lb. of fuel per horsepower. This is based on the assumption that the engine carries practically its full rated load, and that it is new or in first-class condition. With the cup type, while tests show as high as 15 hp. per gallon of fuel, in ordinary operation the engineer should be satisfied if he secures 12 hp. per gallon, corresponding to about 0.6 lb. per horsepower.

Since all engines of the semi-Diesel type carry a compression of about two-thirds of that carried by a Diesel, it is but natural to expect that the details of operation and maintenance will closely conform to standard Diesel practice. Furthermore, with certain grades of oil the maximum explosive pressure often exceeds the maximum pressure in a Diesel engine. On account of these high pressures, the semi-Diesel engine should be made as heavy and sturdy as if it were a true high-compression engine. The majority of builders of semi-Diesel engines are realizing this fact, and at the present time several such engines are built with extremely heavy frames and crankshafts.

Safeguarding High-Voltage Wires

Employees of a laundry having been granted permission to use tools and a workbench in a near-by power house, decedent was in the place when a co-employee approached with a long piece of pipe which was to be cut and threaded. The co-employee, in attempting to open a door leading into the power plant elevated the pipe in such way that it came in contact with an overhead wire carrying 600 volts of electricity. The wire being insufficiently insulated, a deadly current passed down along the pipe, through the co-employee's arm and the latch of the door which he was holding and into the body of decedent, who had just taken hold of the latch on the inside of the door. The shock killed decedent, although his co-employee was only badly injured.

In a suit which was brought by the decedent's widow against the power company, to recover damages, it is held by the Kansas City Court of Appeals to have been a question for the jury to determine whether the company was negligent in failing to properly insulate the wire, although it was 10 ft. 3 in. above the ground, since it might have been foreseen that someone might attempt to pass the place with some long conductor of electricity. (Ratliff vs. Mexico Power Co., 203 Southwestern Reporter, 232.) The court reaffirms the now well-established rule of law that one transmitting deadly electric current must take every reasonable precaution to avoid such accidents as may reasonably be foreseen.

Something About Hand Firing

Several suggestions have been put into operation and Joe Beards, the engineer, finds that his boiler-room conditions have improved. Some of the changes made and the results obtained are cited, also more advice is offered by Willis, the visiting engineer.

THE next time Willis dropped in to see Joe Beards, engineer at the Bartlett Tool Works, which was several weeks after his first visit, he found Joe whistling a lively tune and apparently at peace with himself and the world.

"What happened, Joe?" asked Willis. "You appear as happy as a clam at high tide. Things must be coming your way."

"Just a few," responded Joe, as he glanced at the steam gage on the engine-room wall. "You see, I took your advice and fixed up some of the loose ends around here, with the result that I am getting along on three boilers instead of four."

"How did you do it?" asked Willis, as he leisurely filled his pipe. "Get after some of those leaks I pointed out the other day?"

"That's just what I did. I also took your advice and went into the boiler room more frequently than I had been doing, just to show who was boss out there, as you suggested, and believe me, I got a jolt."

"What did you find?" asked Willis, with a twinkle in his eye. "Nothing more than what you expected, did you?"

"I did, believe me. I supposed I had a couple of firemen who knew how to fire boilers—they had been here long enough—but what did I find? First of all I looked at that pipe for blowing tubes and saw the cobwebs over it, just as you did. Then I opened up the fronts of the boilers and took a peek at the tubes. They were a sight; the soot so filled them that mighty little heat could get into the water through the tube metal. I got the fireman on the job on the jump and with the aid of some choice adjectives got those tubes blown out, and I have seen to it that they were blown out once every day since and that a scraper is run through them once in two weeks. Perhaps you won't believe me, but in ten minutes after those tubes had been blown the safety valves popped."

"There is no reason not to believe it," replied Willis. "In fact, I would have been surprised if they had not. If you had had a thermometer connected to your uptake you would have seen the temperature of the gases going to the chimney considerably lower than they were before the tubes were blown. I'll make a bet that they were at least 75 degrees lower."

"I won't take a bet, because my belief is that the gases were even lower than the figures you have given. I concluded that if these firemen didn't know enough to blow the tubes, which was to their own advantage as well as to the plant's, there would be other things that they were falling down on, and so I began to watch how they handled their fires. I got a shock. Those ginks would throw in all the coal they could, on both sides of the furnace, slam the fire-doors closed and race for their benches. The one who could sit and smoke his pipe the longest seemed to be the best fireman, from their point of view."

"Poor practice," said Willis, "but there are a lot more like them."

"Perhaps there are, but they don't work in this plant now. I talked a little Kaiser Bill into 'm and told 'm to fire light and often and not to work on the idea that they had to fire a week's supply of coal at one shift."

"You are right there, Joe. Better results can be obtained, in my opinion, by the spreading method than by any other, because a better efficiency can be obtained, a higher CO_2, a lower gas temperature going to the chimney and a more uniform steam pressure can be maintained. I suppose you told your men why you wanted them to use the spreading system of firing?"

I POINTED OUT THAT IT WAS EASIER TO SHAKE DOWN THAN TO PULL CLINKERS

"Why no, I don't know that I did; what's the use?"

"If a man don't know why he is doing his work in a certain way, he will never know when his work is being done right. We just spoke of efficiency, and that brings to mind a skit I read in the *Saturday Evening Post* recently.

"The president of a railroad started an efficiency campaign on his system. One name that came to him was that of a fellow who had in 22 years of service never been away from his duties a day, never been late, and never been reprimanded for inattention. Well, the president was mightily pleased, and he sent for the man to come to headquarters to be rewarded.

"Next day Old Fidelity showed up. 'Now,' said the president, 'I have heard splendid things about your record, tell me just what are your duties.'

" 'Well, sir,' said the shaggy-headed, middle-aged fellow with rough clothing, 'it's my job to stay on the platform out here at Holidayville, and every time a train pulls into the station I walk down along her and rap on all the wheels with a hammer. I been doing that steady ever since I went to work for the road.'

" 'In the name of heavens, what do you do that for?' demanded the astonished president.

" 'Well,' this fellow with the efficiency record scratched his head and slowly answered, 'Boss, I'm dom ef I know.'

"Get the point, Joe? There is no use in making a fireman do the work your way unless you tell him the why of it. Doing the thing the way they have been told and just because they have been told will never make them firemen, not in a thousand years. What you want to do is go out into your boiler room and I'll bet you a couple of cheap cigars that if you ask them why they are firing the spreading system, they will give you an answer about like that railroad fellow with the hammer gave the president.

"The reason they used to fire in the coal and then see who could sit the longest before firing up again was because they thought they were getting through the day's work with the least effort possible. They had nothing to work for but 6 o'clock and quitting time. If they knew that a fireman can make his work interesting by studying the results that come from different methods, they would not have waited for you to stop them from firing in the old slam-bang method they used to use. When you arouse a man's curiosity, you have him going. Tell them about the saving of coal that can be made; why the air can get up through a thin bed of fuel better than it can through a thick one, which more than likely is half ashes and clinkers; tell them how cold air rushing into the furnace through the firing doors while they are open chills the furnace and prevents the combustible gases from igniting and so, of course, goes up the chimney without being burned. Tell them all you know about firing and don't forget to make a strike for an increase in their pay. Remember they will wear out more shoe leather with frequent firing than they will under the old method of fill her up and then sit down for a half-hour while the charge is burning up."

"Perhaps you are right; I'll try it anyway. But that isn't all. I remembered what you said 'bout mixing the ashes with the live coal, so I hung around off and on to see how they handled things between firing. It was just as you said. Instead of shaking down and getting rid of the ashes that way, with the exception of leaving enough to protect the grate from the heat of the live coals, they would run a bar in under both ashes and fire and then, with main strength and ignorance put their weight on the other end of the bar and make as thorough a mixture of ashes and live coals as you ever saw. The result was that the ashes fused and then they had the fun of pulling out a bunch of clinkers from the furnace door when cleaning fires, and they were some size at that.

"I talked Kaiser Bill to them again and showed them how it was better to shake ashes through the grate. Then I pointed out that it was a blamed sight easier to shake down than it was to pull clinkers. That seemed to make an impression, and since then they have been using the shaking bar to good advantage and find that it pays to use their heads.

"I guess I didn't tell you that I have put in a draft gage. It didn't take long to show those firemen what a difference it makes when the fires were dirty and when they were clean, and then the men began to experiment. They found the thickness of the fire and the amount of ash on the grate made a big difference in the drafts."

"What were some of the stunts they pulled off?" asked Willis, with interest.

"First of all they noticed the reading of the draft gage with the furnace doors closed and the ashpit doors open. Then they closed the ashpit doors and noticed the gage showed an increase in draft. They couldn't understand that until I showed them that although the gage indicated a greater pull on the furnace side, the gases were not moving through the furnace as rapidly as before, because there wasn't as much air coming into the furnace. To prove this they opened one of the furnace doors and could feel the air rush in, and an examination of the draft gage showed that the pressure had been considerably decreased. Then trials were made with various thicknesses of fuel beds. They found that with our load, a fuel thickness of about ten inches gave good results and about eight shovelfuls of coal was about the best at each firing at intervals of about six minutes."

"You will find that your method would have to be changed with a greater or lesser draft. That is, with a higher draft the firing periods would be, say, every four minutes, and with a much weaker draft they could be lengthened to, say, ten-minute intervals. Just as soon as the firing intervals are greater than ten minutes you are getting back toward the conditions you formerly had; that is, the fuel bed is getting so thick as to prevent the free admission of air through it which is a condition you don't want.

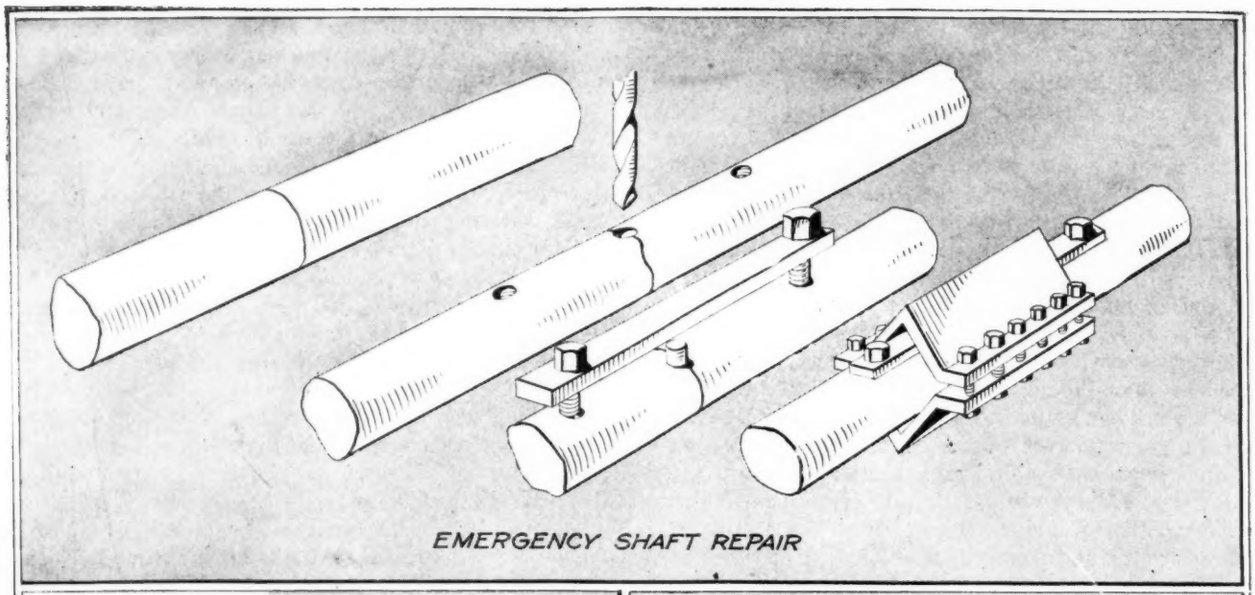
"I can't see why there is such a necessity for firing quite so often as each four minutes. It makes quite a difference to the firemen and makes their job nearly a continuous performance. I don't know as they would stand for it," answered Joe.

"There is more than one way of killing a cat," replied Willis. "First of all you might show them that by proper firing they would not have to fire as much coal per day as they would otherwise. That would be because with a light and frequent firing the volatiles in the green coal are at once distilled and it will take only about four minutes to do it. When a heavy firing is put in the furnace a large amount of air must be admitted over the fire, and when the volatile matter has been liberated by the heat this excess air should be cut down. Now that is something that most firemen would not take the trouble to do, and if they would, the thing is practically impossible because with most hand-fired furnaces the air supplied is constant, so to speak, and as a result, with a heavy fire, the air supply is insufficient and therefore the volatile gases are not properly consumed and you have incomplete combustion. Light and frequent firing reduces these losses, and if the men keep it up they will find that it is to their advantage to continue this method.

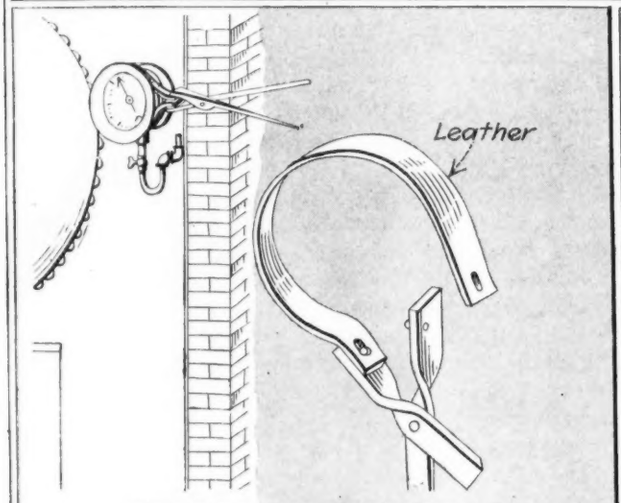
"There is enough that can be said about firing to make a big book, but you are on the right track and the first thing you will want to try out will be a boiler test. It will be a good thing, and the result will show your men whether they are doing their part in operating the plant.

"I guess this will be enough for this time, so I will start for home and see if I can get there in time to get shaved before the movies start."

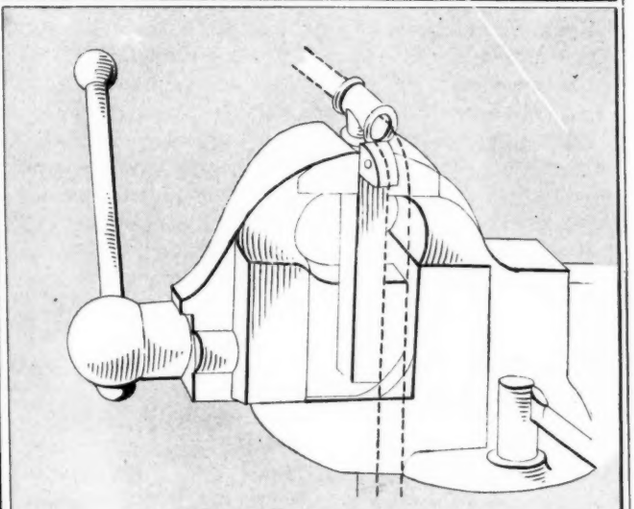
Some Handy Power-Plant Kinks



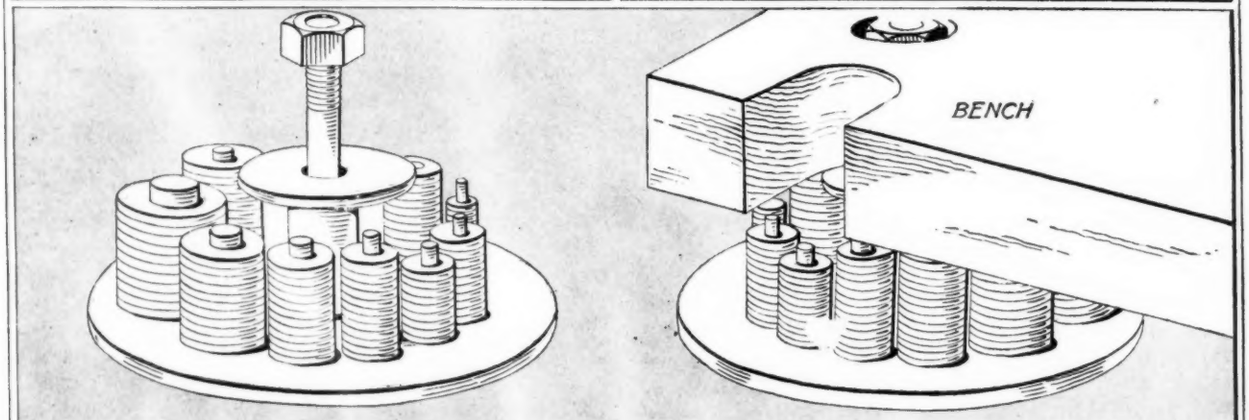
EMERGENCY SHAFT REPAIR



REMOVING STUBBORN GAGE CASING WITH LEATHER STRAP



QUICK PIPE BENDING RIG



WASHER HOLDER FOR THE POWER PLANT

Purchasing a Brine Pump

By B. N. EVERETT

There are several points to consider when purchasing a pump. Sometimes the purchaser buys the lowest-priced one and finds it will not meet requirements. In this article the engineeer recommends a centrifugal direct-connected unit and shows why the pump he favors is, although higher-priced, better than others quoted by the general manager.

THE firm needed a new brine pump to replace a duplex steam pump that was worn out, and the management decided to use a motor-driven pump for the service. The engineer recommended a direct-connected unit consisting of an induction motor and a single-stage centrifugal pump. The head of the suction and discharge were determined from readings taken when the steam pump was in operation, and the capacity was determined by figuring the displacement of the steam pump when supplying the maximum demand. The engineer got a price from a manufacturer on a pump which met the requirements as to speed, capacity and head when pumping brine, and recommended it or its equal to the manager.

The manager remarked: "It is certainly a simple and neat-appearing little thing and the price is less than I anticipated, but will it do the business?"

The engineer assured him it would, but the manager decided to write to some other manufacturers about as follows: "Gentlemen: Please quote us price on a motor-driven brine pump of —— capacity, suction-head pressure 40 ft., discharge head 80 ft. Please send specifications and cut." He added the note: "Our engineer suggests a centrifugal pump," on the letter to a refrigeration engineering company.

Some time later the engineer was called to the office. As he entered the door, he noticed a look of puzzled amusement on the face of the manager, who had a number of letters spread out on the desk before him. Looking up, his face assumed the conventional expression of the executive with a subordinate "on the mat."

"See here, chief, do you still stand by your brine-pump recommendation, service, durability, price and everything considered?"

"Yes, sir," answered the chief; "but as you know, I'm always ready to listen to other people's ideas."

"Yes, I know, and I also know you delight in showing up my ignorance when I try to butt into your department, but this time I leave the arguments to someone else. For instance, regarding price, here is B's pump recommended by its manufacturer for the services which you specified." Here he paused significantly. "And the price is only 57 per cent. as much as the one you suggested. That means a difference of 43 per cent. It looks about the same to me as the other, and seems to be the best price we have received." Here he handed the chief the catalog and letter at arm's length, with an attitude which said, "There, that's too much of a discrepancy."

The engineer, after a moment's examination, said: "No, we don't want this pump," and went on to explain. "The cost of this pump is very little less per pound, but the design of A's pump makes it necessarily heavier. The motor which will drive the pump has the best type of ring-oiled bearings, as the pump should also have. You will notice B's pump has plain babbitt bearings. Besides, the impeller of A's pump is hung between the bearings, but B's is at one end of the shaft. A's has a double-suction, balanced, inclosed impeller, which is more efficient than B's single-suction, unbalanced open runner. A's pump can be dismantled for examination or repairs without breaking the pipe connections, but with B's this is not so. Besides——."

"Why do they make such a cheap pump?" interrupted the manager.

"For intermittent work, draining pits, excavations and such service where price is the main consideration. Our brine pump will run 24 hours a day the year around. Many pumps will not operate as much in ten years. I figure the difference in power consumption between these two pumps will pay pretty good interest on the difference in price."

"Yes, no doubt. Well, we have eliminated B's pump." The chief raised no objection to the "we."

Picking up another letter and circular, the manager said: "Now here is a letter from the Iceberg Ice Machine Co., and you will remember I was skeptical in the first place about a centrifugal pump. They say: 'It is common practice with us to use triplex-plunger pumps for brine circulation when power pumps are used, and we are quoting you on a pump of the capacity you require, together with bedplate and chain drive for connection to the motor. It is our impression that a centrifugal pump will not lift water 40 ft. on the suction side, but if the centrifugal-pump manufacturers have a pump suitable for your specific service, they will no doubt give you a guarantee.' There, what do you think of that?"

The chief replied: "I guess he's right about a centrifugal pump not lifting water 40 ft. by suction."

"Well, that's according to the note you gave me—40 ft. suction, 80 ft. discharge."

"Yes, but I said 40 ft. suction head, not lift. The brine flows to the pump under pressure."

"Oh, yes, of course." The manager paused and then continued: "I have always had great faith in the Iceberg Company. What do you think of the pump they offer?"

"How does the percentage of cost compare with A's centrifugal?"

"Just 216 per cent., but," with a smile, "the cost per pound compares favorably. But cost in a pump in 24 hours' service is a minor detail compared to durability and efficiency. I understand triplex pumps are the most efficient type made."

"Yes, ordinarily, but for such low heads as 40 ft. I doubt it, everything considered, packing for three large glands, grease, oil, interest on the difference in price, rent for floor space in the engine room, cotton to put in the operator's ears, etc."

The manager smiled. "I had thought of that," he said; "the doggone thing is so big we couldn't put it where we wanted to. But why does the Iceberg Company use them?"

The chief thought a moment and then replied: "The head against which a brine pump operates is caused by the friction of the brine through the pipes, and what this friction head will be is hard to determine before the plant is in operation. A centrifugal pump must be properly fitted to the head against which it pumps. That probably has something to do with it, but I think it is largely due to precedent and to the carelessness of manufacturers in recommending cheap pumps for such exacting service."

Well, they bought A's centrifugal pump, the manager remarking "We pay you for your advice, so I suppose we'd better follow it."

Some time later, when the manager was on one of his frequent "nosing around tours," the chief saw him admiring the steadiness of the pressure gage on the brine pump's discharge line. This same gage used to continually wabble with uncertainty when the old steam pump was on the job. Seeing the chief, he said:

"There is one thing I have noticed about this brine pump that doesn't seem just right. The brine is not quite so cold as it was when using the steam pump. Why is that?"

The chief grinned and answered by asking, "What would be the brine temperature if we shut the pump down entirely?"

"It would soon become the same as the ammonia that cools it."

"And why do we use the brine pump?"

"Oh, I see it. We are simply pumping the brine faster and so bringing more heat from the coolers to the brine tank. I have noticed that room No. 7 is always kept at the proper temperature now. It sure does the business all right, don't it?"

Engineering Council Seeks Committee Helpers

ENGINEERING Council, as was designed, is engaging in numerous activities for the engineering profession of America, many of these being directly or indirectly connected with the war. The council is a body of representatives from member societies conducting most of its work through committees. For effectiveness these committees have usually a small number of members, although committee membership is not limited to the representatives on Engineering Council. Men have been selected for committee membership because of broad knowledge and extended experience in the field assigned to the committee.

As the work of some committees develops, however, there are occasions when helpers are needed who can devote time to details, to special investigations, to getting local information in some community or state, to compiling and analyzing information already accumulated, or to scouting for men needed for some particular service. When need arises for such assistance it is often difficult to think of or to find the right man available at that moment. In order to meet this difficulty, to give a larger number of engineers a share in the activities, to broaden the council's contact and gain greater breadth for its views and statements, as well as to make its work more widely known, Engineering Council is requesting engineers who can help, to write to the council's office, registering their names and addresses and in a general way stating the extent and nature of service each is willing to render. This is an opportunity for some of the younger members of the profession to take a hand in society activities, but the request is not limited to the men of few years. Of course everyone registered may not be called upon, or it may be a long time seemingly before a given volunteer is asked for help. On the other hand, calls may come promptly and frequently, and opportunities may be afforded for services of no small value to the profession and the public.

To indicate a few lines of Engineering Council's work, brief statements are given about some of the committees. The Public Affairs Committee reports on matters of public policy and those relating to National, state or local government, other than technical questions. One question of active interest now before this committee, for example, is that of licensing engineers.

The American Engineering Service has the duty of compiling as complete a classified catalog of the engineers of America as it may be practicable to get together. Much information has been assembled but a great deal remains to be collected. During war time lists collected by this committee and the engineering societies coöperating with it are being used to supply thousands of names in response to calls from Government departments for specialists for combatant and other forces of the Army and Navy and for the war industries. This committee frequently could use volunteers, not only in New York but in distant communities also, in scouting for men to meet special and urgent calls from the Government as well as in other ways.

The War Committee of Technical Societies is engaged upon the examination of new inventions offered to the War and Navy Departments and to the stimulation of the development of useful new appliances for warfare. In reviewing ideas received, preparing bulletins and writing reports and records, this committee could make use of a number of helpers from time to time.

The Water Conservation Committee is organizing to deal with questions of policy in various parts of the country concerning the utilization and control of water for such purposes as power development, navigation, irrigation and municipal supply. This committee will need correspondents to aid it in keeping informed or in special investigations about local laws and policies.

Engineers who are able and willing to take some part in this service for the profession should communicate with Alfred D. Flinn, Secretary of Engineering Council, 29 West 39th St., New York.

Where a contract to install a boiler specified a particular type made by a particular manufacturer, and there is nothing to show that the boiler installed failed to conform to this description, the buyer is not entitled, on being sued for the price, to show structural defects by comparison between the type of boiler and other patterns of boilers. So held the Missouri Supreme Court recently in the case of Bradley Heating Co. vs. Thomas M. Sayman Realty and Investment Co., 201 Southwestern Reporter, 864.

Estimating Power Requirements of a Locality

By LUDWIG W. SCHMIDT

THERE is possibly no power engineer who has not at some time felt the necessity of estimating the demand for electrical power likely to be expected from a given locality. The occasion to make such an estimate arises most frequently during the early stages of discussion of a hydro-electric power enterprise, especially when there is doubt as to how much of the power obtainable by the site should be developed immediately. The inclination of every power engineer is to go to the limit, because he knows that only by so doing will he be able to supply power at the lowest possible rate. The question to be decided is, whether there will be a sufficiently large demand for power to justify the total development. A correct estimate of the power capacity of the district must therefore be of great importance. Not only will the cost of the plant and of the power produced depend a good deal upon the size of the business that can be expected, but many other questions of policy will have to be decided on the strength of such an estimate.

Conditions Necessary to Form Approximately Correct Estimate

Demand for electrical energy comes to the central station from two distinct sources. The first and in some cases the principal source is that originating in the power demand for street lighting, the running of tramways and similar municipal activities. The second results from the industrial power employed in the neighborhood. To make an approximately correct estimate, therefore, it will be necessary to establish:

1. The power produced and sold by the minor public utilities already operating in the district under consideration.
2. The actual horsepower employed by industrial enterprises in the district.
3. The electrical power in use in the district, not bought from the existing producers and distributers.
4. The electrical power likely to be employed in the future in the district after the new central station has begun operation.

When a new and powerful central station is built in a district, it will as a rule slowly supersede the existing enterprises, which either will lose part of their business to the stronger competitor or will make arrangements for buying their own power from the new enterprise, acting then merely as distributers. The latter is the more frequent and also the more desirable. In fact, most central stations today are built with the express purpose of consolidating power production in a given district and thus reducing the cost of generating in the existing smaller enterprises. In making his estimate of the possible consumption, the engineer will have to inquire at first as to what part of the business held by the minor enterprises can reasonably be expected to accrue to the new central station.

It is to be assumed that before the actual work of construction begins, agreements have been made with some of the existing stations as to the new power they are likely to require for their own use, and in this case it is fairly simple to estimate the consumption to be expected from that source. Difficulty, however, exists in cases where no such agreements have been made or where the time for making them has not yet come, and also in cases where only some of the existing power stations have agreed to buy power from the new station and where it will enter competition with the remainder. Under such circumstances, the principal question to be settled is whether the new enterprise can expect to gain on the trade held by those central stations which have not become customers, or whether it can make them an offer sufficiently attractive to induce them, also, to buy their power from the new enterprise.

This question cannot be decided correctly unless the person making the estimate knows approximately what will be the cost per unit of power sold by the new central station. The first step to be taken, therefore, is to make an estimate of the cost per unit to the new central station under a partial and full development of the available power. With this knowledge it will then be possible to establish fairly exactly what part of the power already sold in the district will be transferred to the central station and what part will continue to be generated independently.

There are thousands and thousands of industrial establishments in the United States which continue to operate their own generating stations in competition with central stations for the simple reason that it is more economical for them to do so. To capture this business the central station must sell current at a rate below that at which it is produced by the consumer in his own generating plant. The same rule, therefore, which applied to the central stations existing in the district will also apply to the private generating plants. Their business will be obained only if the new central station can sell at a competitive rate.

What the Rate Should Be

What the rate should be in both instances is not very difficult to decide. The cost per unit sold by the semi-public and public utility in any given locality is well known, and there are plenty of means to obtain the necessary data. It is less easy to establish a reliable figure as to the cost per unit in the private generating plant of a factory, because conditions vary a good deal, and the result at the best must remain guesswork. There is, however, one certainty—in the majority of cases it will be below that charged by the existing distributers of electric energy; otherwise, these distributers would already have obtained the business of the private producer. If, therefore, an estimate of the probable cost per unit in the existing private generating plants has been made, it may be checked by comparing the result with the charges made by the larger distributers. Its correctness may be assumed if the figure obtained is below that charged by the latter.

The most elusive factor is that of the custom to be expected from those industrial plants in the district which so far have not made use of any kind of electrical energy. To make such an estimate seems impossible at first thought. Nevertheless, there are instances in which such an estimate may be required. For ex-

ample, it may be of interest to know the minimum of business that can be expected from the industrial establishments of the district, and an answer to this question can be given. Some time ago the writer was asked to make such an estimate under rather peculiar circumstances.

The original proposition for the construction of a large central station came from a number of smaller consumers of electrical power, all of whom had their private generating plants; but they were of the opinion that it would be more to their interest to shut down the smaller stations in favor of one big central station, which would not only take over the supply of the power needed by the existing producers, but also take care of the general business in the district, which included the lighting of streets and houses and probably the running of a small tramway, operated until then by horses. A consulting engineer was employed to work out the project, and he advised the use of a water-power site which appeared to produce all the power needed by the district, but had the disadvantage of running rather low during certain times of the year. So the question arose whether it would be advisable to develop only a part of the power and be sure of an even supply all the year round, or whether the total power should be developed and a supplementary steam plant installed to help out in case of need. The expert strongly advised the latter course, and the whole discussion finally centered around the problem of whether or not the district would be able to consume all the power available.

Probable Consumption of Energy

As to the possible consumption of energy for public purposes, conditions were known and no difficulty existed. On the other hand, there was much doubt with reference to the probable industrial consumption. The minimum, of course, would have to include that part of the total consumption which was already supplied by the existing private plants to their own establishments and in a few instances to other industrial consumers. The facts as to the industrial conditions of the district in question were fairly well known to the engineer and the promoters of the scheme. It was a district of mixed industrial activity, including a few agricultural machinery shops, several automobile repair plants and garages, a small shoe factory, several canning plants, a number of textile mills, and a factory making cigars. In addition, there were many other factories of the character found as a rule in connection with any community of average size. The original plan of estimating the demand for electric power to be expected from all these firms was to make a general estimate of their power consumption and then see what amount might reasonably be expected to be transferred to the central station. This system, however, was not considered accurate enough, and finally another was selected which seems to have given good results.

It was argued that the minimum power consumption to be expected in the district when cheap electricity should become available, would be at least that of the national average used in the various industries represented in the neighborhood. The safest way to estimate this average would be to calculate the power consumption per wage earner employed in each industry in question. This average certainly would give a better result than one based on the average power employed per establishment. The first step was to run over the list of industrial establishments in the neighborhood and to allot to each establishment the approximate number ot hands employed. This, in the case under consideration, was fairly simple, because the establishments were intimately known to the promoters. With the help of these figures an average of the power consumption to be expected was drawn.

To make this possible another list had been compiled from the United States Census Reports, showing the average power employed by the national industries represented in the district. As an example a few of the items of this list are given below:

	Number of Wage Earners	Horsepower Used per Wage Earner		
		Total	Electric Power Total	Electric Power Rented
Agricultural machinery	48,459	2.5	1.7	0.6
Automobiles	127,092	1.3	1.0	0.8
Boots and shoes	206,088	0.5	0.3	0.1
Canning	74,071	1.6	0.3	0.2
Carriages	52,391	2.1	0.6	0.8
Cement	27,916	17.8	5.4	5.1
Cotton goods	393,404	4.0	1.3	0.6
Glass	74,502	2.1	1.2	0.2
Rubber goods	50,220	3.2	1.8	0.5
Tobacco	178,872	0.2	0.1	0.06

The number of hands employed in each industry in the district was multiplied by the average horsepower per wage earner in that industry, as shown in the table, and the sum of the products gave a fair idea as to the total power requirements in the district. A second estimate was made with reference to the total electric power which under average circumstances would be employed, but from the total was deducted the electric power already known to be employed. A third estimate was made as to the average electric power likely to be rented, and here again the electric power known to be already employed in the district was deducted. An average then was drawn of the results of the second and third estimates, which, it was thought, would represent as nearly as possible the increase in the demands for electric power which might be expected as a result of the coming of the new central station. The outcome of the experiment has shown that the way of estimating in this case was correct and that the result obtained was as near to the facts as could reasonably be expected.

In this specific instance the work of estimating had to be done for a small district only, which involved both advantages and disadvantages. The principal advantage was that it is much easier to collect information in a small field; on the other hand, every statistician knows that it is much more difficult to obtain a correct average in a limited field than over a wide range. Also, it is as a rule much easier to obtain statistical information for a large district. The census reports and all other statistics collected by the Government and needed for making the estimate as a rule detail only for whole districts and rarely go so far as to specify the smaller cities. They are consequently more likely to be representative.

The foregoing method of estimating has been found very useful in making other estimates of probable power consumption. It comes handy when estimates have to be made covering large areas in countries where there has been little electrical development. It also may be employed to determine the commercial value of hydro-

electric properties offered for sale. Estimates of this nature are based on average conditions, and there is always the possibility that the case under consideration offers certain exceptional characteristics, which, by overthrowing the law of averages, will affect the results of the estimates.

Proving Cause of Explosion

The recent decision of the New York Court of Appeals, concerning the liability of an employer for injury caused by the explosion of a locomotive boiler, appears to be fully applicable, in legal principle, to explosions of stationary boilers.

The decision, which was handed down in the case of Francey vs. Rutland Railroad Co., 119 Northeastern Reporter, 86, is to the effect that the general rule of law that where an accident happens under such circumstances that it may reasonably be inferred, in the absence of evidence to the contrary, that it was caused by negligence of the person sought to be charged with responsibility, such person has the burden of affirmatively disproving negligence, does not apply to the case of an explosion of a boiler, where the facts are such that the accident might be attributed to either one of two causes—negligence on the part of the employer in failing to keep the boiler in proper repair, or negligence of the engineer, suing for damages on account of his injury, in letting cold water into the boiler under conditions existing at the time. It is held that where at first blush an accident resulting in injury to an employee may be attributed to his own carelessness with as much show of reason as attributing it to the fault of the employer, the employee has the burden of proving that negligence of his employer was the direct cause of the accident.

It appears that the explosion in this case followed from admitting boiling water and steam to the locomotive firebox, due to a flue having been forced out of place and thus leaving an opening.

Heat Prostration as "Accident"

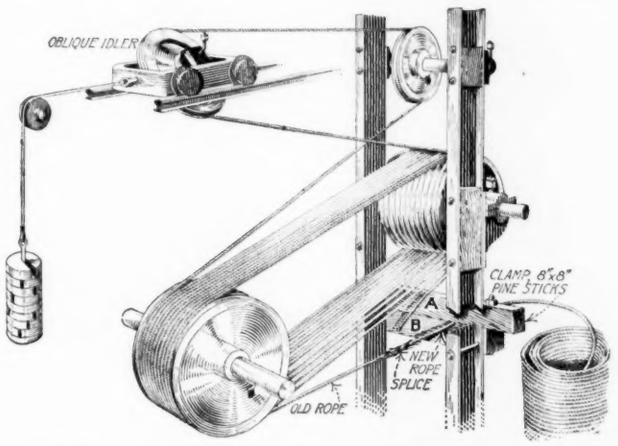
Where an employee engaged in removing the old and placing new brickwork around one of the boilers of a steam-power plant died as a result of heat prostration, it not appearing that he exercised in any unusual manner, or to an unusual degree different from other employees engaged in the same work, his death cannot be deemed to have been "accidental" in the sense of warranting an award in favor of decedent's dependent relatives under the Michigan Workmen's Compensation Act. This is the holding of the Michigan Supreme Court in the recent case of Roach vs. Kelsey Wheel Co., 167 Northwestern Reporter, 33.

Kinks in the Handling of Rope Drives

BY A. J. DIXON

IN replacing an old rope with a new one in a system of rope transmission of power, it is often the practice to put a tension on the new rope as it is drawn in, by stationing a crew of men like a tug-of-war team to pull against the winding force. A more effective means is shown in the sketch herewith, which represents the principal details of a drive in which 1000 ft. of 1¾-in. manila rope makes eleven wraps around the main sheaves, and which is designed to transmit 200 hp. One man can apply the needed braking force on the rope as it slips through the clamp *AB*.

The rope comes from the factory wound up in a coil around a hollow core. The coils are unwound internally, and the unwinding must be started with the coil right end up, otherwise the rope will kink so that it will be impossible to draw it onto the sheaves. In putting on a new rope one day the coil was inadvertently placed wrong end up. After the splice was made to the old rope, the mistake became apparent by reason of the twisting stress against the strands of the new rope as it was drawn out at the coil. Being in a hurry to finish the job, however, and not wishing to lose the time necessary to change the splice, the superintendent decided to let things remain as they were, hoping to be able to straighten out the kinks as the rope passed through the braking clamp. By the time two wraps had been drawn onto the sheaves the section of rope between the coil



THREADING NEW ROPE THROUGH TENSION CLAMP

and the clamp had become a hopeless tangle of kinks. The job had to stop until the rope could be unwound from the sheaves, the splice cut, the coil turned over and the free rope straightened out and drawn through the hollow center in the right direction.

Although the work of putting on one of these ropes would not ordinarily be classed as hazardous, it came very near being fatal for one of the hands engaged on the job recently. This man had been detailed to pull the rope out of the coil. In some manner that he could not explain, he got a turn of it around his waist, and before he could extricate himself the rope tightened and he was dragged irresistibly along. Luckily, the engineer was within instant reach of the throttle, and in response to the imperiled man's frantic yells he succeeded in stopping the engine just as the man was drawn up against the tension clamp.

When the pull on a driving rope fluctuates considerably, as where power is transmitted to rock crushers or other apparatus in which the driving effort may reach a maximum one instant and a minimum the next, the variable tension in the fiber of the rope will be accompanied by a corresponding vibratory stress. In a main drive like the one shown in the drawing, the vibration

will sometimes cause the length of rope passing from the oblique idler of the take-up device into the first groove of the driven pulley to lash violently from side to side. Occasionally, this whipping action will result in throwing the rope out of its proper groove in the driven pulley, thus causing it to ride around on top of the wrap running in the second groove of the series. This has happened several times without any damage resulting, the rope being guided back into the empty groove by means of a piece of pipe used as a shifter and without slowing down the engine. Great care must be exercised in doing this, however, as undue haste might result in shifting the rope past the vacant groove and off the pulley altogether, perhaps with disastrous consequences.

It does not require a very great force to shift one of these turns of the rope when the force is applied just right. On one occasion the oiler stepped up on the rim of the crank-end dashpot of the engine to reach the top of the governor spindle with his oil can. He lost his balance, and in grabbing at a railing near-by to save himself from falling, he threw the oil can so that it fell on the rope drive which was running alongside. The can traveled once around the main driving sheave and was thrown out undamaged, except for a dent that did not impair its usefulness. It had exerted force enough, however, to pry the first wrap of the rope out of its groove and throw it over on top of the wrap five grooves away. The engine was slowed down and the length of misplaced rope was gradually shifted back to where it belonged.

When these ropes fail through ordinary wear and tear, the failure naturally occurs in the splice, the weakest part. The rope begins to frazzle out and usually gives warning of the impending break in plenty of time to make whatever preparations are needed for a temporary shutdown. It is then necessary to cut out the whole of the old splice, and make a new one, since the strength and durability of a fresh splice with part of the old one left in would suffer impairment in exact proportion to the extent of rope remaining from the old splice. In the drive shown in the sketch the rope ends to be spliced are lapped 24 ft., thus making the splice extend 12 ft. each way from the joint. If the oblique sheave in the take-up device is out far enough to give something more than 24 ft. of slack rope, then an entirely new splice can be made and still the shortened rope will be long enough to run in all of the grooves in the main sheaves. If this much slack has not been taken up, then it might be advisable to unwind the rope from one groove in each sheave and thus sacrifice the pulling power of one wrap in order to make a sound splice.

It would generally be better to do this with an old drive than to splice in a short length of new rope. If the requirements of the service, however, make the new rope necessary, some difficulty may be experienced after the splicing has been done, since the wear and stretching it has undergone naturally make the old rope smaller in diameter than the new portion. The piece of new rope should be stretched before it is spliced in. This may be done by fastening it in some convenient place and pulling on it with block tackle of some kind, letting the rope stand awhile after getting a good tension in it and tightening up on the tackle occasionally. But even with this treatment the new rope will still be somewhat larger than the old one. The difference in size will put a jerking stress in the old rope just ahead of the splice at one end and just back of the splice at the other end as the piece of new rope passes on and off the sheaves. The difficulty might be avoided if a new rope having a diameter about one-sixteenth inch smaller than the nominal diameter of the old rope could be obtained.

ALBERT H. WIGGIN, *Honorary Chairman*
State Fuel Administrator
GERRIT Y. LANSING, *Chairman*
Representing Fuel Administration
EDWARD J. CHENEY, *Secretary*
JAMES M. KITE
Representing Public Service Commission
J. T. HUTCHINGS
H. W. PECK
STUART WILDER
Representing Empire State Gas and Electric Association
ROSSLYN M. COX
Representing Conference of Mayors
A. E. CLUETT
Representing Association of Manufacturers and Merchants

UNITED STATES FUEL ADMINISTRATION

NEW YORK STATE FUEL ADMINISTRATION

PUBLIC SERVICE COMMISSION, SECOND DISTRICT

COMMITTEE ON FUEL CONSERVATION

55 NORTH PEARL STREET, ALBANY

June 17, 1918.

Gentlemen:

Under ordinary circumstances, the conditions obtaining in a power plant are not of pubic concern. With the supply of coal alarmingly short and transportation facilities overtaxed, the conservation of fuel becomes a matter of extreme public concern.

We are advised that you are operating a steam driven power plant and that the electric power company in your locality can furnish you with energy without great expense on their part or yours for transforming or line equipment.

While we have not ascertained the detailed facts in your case, we know that in general the larger power plants require very much less fuel per unit of energy produced than do the smaller plants. It is absolutely essential that fuel be conserved in every possible way during the period of the war. Our efforts include every way that has been suggested to us.

Will you confer with the Utility Company, to whom we are sending a copy of this letter, and endeavor to make such arrangements as to the supply of energy as will conserve the most fuel and as will be mutually advantageous or at least not unduly disadvantageous to either party.

We would call to your attention the fact that Utility Companies stand high in the priority list for fuel. On the other hand we would call to the attention of both you and the Utility Company that the Fuel Administration discourages Utility Companies from soliciting or taking on business from non-essential industries who might otherwise be unable to operate on account of lack of fuel.

Please advise us promptly as to the result of your conference regarding this matter.

Very truly yours,

Edward J. Cheney

Secretary.

EDITORIALS

The Fuel Administration's Attitude Toward the Isolated Plant

SOMEBODY has sold the Fuel Administration a bright idea.

The large scientifically operated central electric station runs on less than two pounds of coal per kilowatt-hour.

The average isolated plant requires four times as much.

If, therefore, all the isolated plants were shut down and made to take current from the central stations, there would be an important saving of coal.

This is a very plausible argument, for which the layman readily falls.

There is just enough truth in it to put it over and to carry with this modicum of truth a lot of misconception.

It is not a fact that shutting down most of the isolated plants would result in a saving of coal. Quite the contrary.

A condensing engine will run on less steam than a noncondensing engine; but it is not always, nor usually, the most economical engine to use.

An engine or turbine that uses ten pounds of steam for each horsepower-hour converts some twenty per cent. of the heat furnished to it into mechanical energy. A noncondensing engine may convert only a third as much, but all the heat not so converted, radiation excepted, goes out in the exhaust. If that exhaust can be all used up, as for heating, cooking and manufacturing processes, the noncondensing outfit will account usefully for all the heat furnished to it except the small amount lost by radiation, and even this often serves to do useful heating.

It is an axiom that where use exists for any large proportion of the exhaust steam, a noncondensing engine is the more economical.

Where there is use for heat at or about the temperature of steam at atmospheric pressure, it is better engineering and less costly in coal to make the steam at high pressure, expand it in an engine to the lower pressure desired for the process and get the power as a byproduct than to make the process steam at a low pressure and purchase the power or make it with a condensing unit having a lower steam rate.

The central-station solicitor dismisses the heating question by telling the prospect glibly that he can make what steam he needs at five or ten pounds instead of a hundred or more.

The ordinary prospect does not know that it takes practically as much heat, or coal, to make steam at five pounds as at one hundred and fifty; and in many cases he will burn as much coal under his heating boiler as he used to burn to make his power and do his heating too.

The statement often made that the average isolated plant burns coal very wastefully does not mean that most of the coal burned in isolated plants is carelessly used. In making the average upon which the statement is based, a multiplicity of little plants, the aggregate coal consumption of which is a small part of the total, are counted in. Isolated plants large enough to warrant intelligent design and supervision are often exceedingly efficient in their use of coal and steam.

There is doubtless a chance for the saving of large quantities of fuel in improving the practice in many isolated plants—and in many central stations, too, for that matter. The Fuel Administration in arranging for the inspection of all power plants and the directing of the attention of their owners and operators to possible methods of saving is doing a work which will not only conserve fuel in this crisis but permanently reduce the operating expenses of many manufacturers. It is much wiser to induce power users to make a more effective use of the apparatus which they have than to drive them to abandon it and buy their power, and then go on and burn coal in the old wasteful way, if they have been wasting it, for heating, etc.

We believe in the Government administration of the fuel supply. We believe that the time had come, even before the war made it imperative, for the Government to see that so vital a necessity as the country's fuel was economically and adequately mined and fairly distributed at a price that would pay the miners and operators a fair profit and no more. We are in hearty sympathy with the activities of the Fuel Administration to these ends, and even with its insistence that the fuel mined shall be used to the best advantage, but we revolt against its being prostituted to a soliciting bureau for the central-station industry.

Read the letter on the opposite page.

Similar letters have been sent out by other fuel administrators. The head of the department has in public addresses expressed the idea of the superior efficiency of the central station and the savings to be effected by purchasing current instead of making it.

One of the strongest motives upon which the central-station solicitor is playing today is the fear of the prospect of being unable to get coal. People are shutting down their plants or putting in auxiliary service or stand-by connections simply because they are convinced that the central station can get coal when they may not be able to—simply as a measure of insurance.

Read the final paragraph of the letter on the opposite page.

The Fuel Administration maintains an engineer whose business was formerly to examine plants with a view to determining whether they might not better buy than make their current. He was employed not by the central stations but by the prospective customer and admits that in over eighty per cent. of the cases in which he was retained he advised the purchase of power from a central station. He goes about the country at the expense of and in the name of the Fuel Administration, preaching before all sorts of commissions and

committees this fallacy of the general criminal wastefulness of the isolated plant and the expediency of abolishing it in favor of the central station.

It is not to be supposed that the Fuel Administration is knowingly lending itself to this misuse of its influence. It is not demonstrable that any sinister influence has been at work to make it the agent of exploiting the conditions brought about by the war in favor of an industry in which many men of affairs are interested. The engineer referred to is probably honestly obsessed with the ideas which he is trying to promulgate. But it is certain that the Administration never arrived at its attitude toward the isolated plant and its disposition to shoo everybody toward the central station through the advice of disinterested steam engineers; and there are plenty of them connected with the service.

However guarded the language of these communications may be, the impression which they convey is that one will find favor with the Fuel Administration, serve his country and save coal if not money by dealing with the public-utilities companies instead of continuing to run his own plant. We suggest that such prompting should be based only upon an assured saving, and suggest an impartial investigation as to the facts in the case with the advice and counsel of unprejudiced steam engineers before any more such exhibitions as that reproduced on page 58 are perpetrated.

Burn Screenings Now and Store Lump Coal

COAL mining in the past has been conducted in an intermittent manner; that is, the mines have worked on short time in summer and at their maximum during the winter months. It is necessary, at this time, if sufficient coal is to be produced for the country, that the mines be operated every working day in the year.

The zoning order, intending as it does to prevent unnecessary cross-hauling of coal with the accompanying tax on transportation facilities, was designed to encourage maximum production in the respective zones throughout the year. Cross-hauling of coal came about in the first place through the efforts of consumers to select coals having characteristics especially desirable for their particular purposes. In certain districts the zoning order shuts off many of the better grades of coal that were formerly consumed in those districts. The result has been that buyers have been and are trying to obtain their supplies from the mines producing the more desirable grades of coal in the zone from which they are permitted to buy. Furthermore, they are using for current consumption large amounts of sized coal from these mines, which should and must be diverted to storage purposes if we are to get through the coming winter without distress. The output from mines in the more desirable fields has been sold out for months in advance and cannot by any possibility supply the demand. In the same zone mines producing the less desirable grades are running only part time for want of orders.

An example of these conditions is furnished in Illinois, the third largest coal-producing state. In the southern fields the demand is far in excess of any possible production. In other parts of the state mines with great producing capacity are idle a large part of the time. The sized coal from these mines compares favorably with the product of other fields, but the demand for screenings from the mines has been so small that an oversupply has accumulated, and unless an outlet is created for screenings, the mines must continue to operate short time with a resultant underproduction for the section.

Unfortunately, these screenings are not adapted to storing, but they are just as good for immediate use as most other coals in the state. To correct this situation, all plants that can possibly utilize Central Illinois screenings should do so and thus release the sized coal and more desirable storage coal, for the domestic trades and for the accumulation of storage stocks for next winter.

Alas! Poor Garabed!

"We, the undersigned, who are members of the Commission duly appointed in accordance with the provisions of Public Resolution No. 21, Sixty-fifth Congress, hereby certify that Mr. Garabed T. K. Giragossian showed us on Saturday, June 29, 1918, a model embodying the principles of his invention known as the 'Garabed.' We found that the model was not in shape to run or to develop power. The inventor admitted that he had no working machine and that he was merely explaining principles. We do not believe its principles are sound, that his devices are operative, or that they can result in the practical development or utilization of free energy.

"Witness our signature at Boston, Mass., June 29, 1918.

"JAMES A. MOYER,
"EDWARD F. MILLER,
"N. DE KAY THOMPSON,
"EDWIN B. WILSON,
"CHARLES L. NORTON."

Why, Mr. Giragossian! What has become of that machine that you told us you had run from early in the evening until two o'clock in the morning? Didn't you tell us that you had run it time and time again and could start it any time you wanted to? Don't you want to now?

A correspondent of the New York *Evening Post* for June 18 pleads for a word of recognition for the engineer and fireman, and all those men who come under the head of engine-room help, be it in the battleship, in the transport or in the merchant marine. These men know that every time they go to sea they take their chances because of their location in the depths of the ship. When the ship is torpedoed without warning, or in a fight, they are the ones who are going to go if she does not happen to last long enough for them to get out, and yet they go on cheerfully and bravely, doing the various duties of the engine room, and show a caliber and type of courage that is of the highest.

The index to Volume 47 (the first six months of 1918) is now ready and will be sent to all whose names are on the index mailing list. Any others who wish will be put on the list. A post-card request is sufficient.

CORRESPONDENCE

A Peculiar Wiring Trouble

The conditions referred to in the letter, "A Peculiar Wiring Trouble," in the issue of Apr. 30, afford an excellent example of why trouble is experienced on electrical systems. In the first place the man who attempted to connect the bell system up with the lighting circuit committed a serious violation of the National Electric Code, and secondly, the engineer that attempted to overcome the difficulty on the lighting circuits by fusing these circuits with copper wire instead of locating the trouble and remedying it, showed himself to be in a class with the individual who tied down the boiler safety valve.

As long as such acts are perpetrated, just so long will electric circuits be a menace to life and property. When all who install and maintain electric circuits and equipment decide that the N. E. Code is something that is to be observed instead of an element to be disregarded except when forced upon them, just so soon will electrical-maintenance troubles on low-voltage circuits become an almost negligible factor. B. A. BRIGGS.

New York City.

Fires in Turbo-Generators

In the article on "Fires in Turbo-Generators," by M. A. Walker, in *Power*, Jan. 22, and the discussion letters by Everett Palmer in the May 14, and by B. A. Briggs in the June 18, 1918, numbers, the use of carbonic-acid gas is suggested as a fire extinguisher. This gas can be conveniently stored in liquid form in a steel drum measuring about 5 ft. in length and 8 in. in diameter and weighing about 100 lb., which will hold 50 lb. of liquid CO_2. The drum must be kept in a comparatively cool place, because if left in the sun or near boilers an explosion might result or the safety disk on the valve, where provided, would blow and the gas be lost. Ordinarily, ⅛-in. iron pipe would be large enough to connect the drum valve to the generator casing if the distance is not great. The outfit would thus be always ready for use by opening this valve.

The chief difficulty in the use of this gas, as pointed out by Mr. Briggs, would be in the freezing up of the pipe. The rapid expansion of the liquid into gas fills the pipe with "snow," white flakes of solid CO_2, and sometimes even the contents of the drum itself will solidify. To overcome this it is necessary to spray the pipe and drum with hot water or cover them with cloths dipped in hot water. This, of course, should not be done until the valve is opened. The gas as it comes from the drum is intensely cold, and this would help to some extent to cool the overheated parts of the machine. The gas, being much heavier than air, should be admitted at or near the highest point of the casing and all means of egress at the bottom be closed.

Mr. Walker says, "carbon dioxide is poisonous." This is hardly correct, at any rate not in the sense that the term is used when applied to such gases as carbon monoxide or chlorine. CO_2 is really no more poisonous than water, although neither can take the place of air for the purpose of respiration, and total immersion in either fluid will quickly cause drowning. The same methods used to revive an apparently drowned person are adopted when CO_2 is the cause of asphyxiation. Carbonic acid is the gas with which soda water and soft drinks are charged. Several drums might be set free in a power house without danger to anyone, but in a small inclosed space a lighted candle should be used to test the air as a precaution before entering.

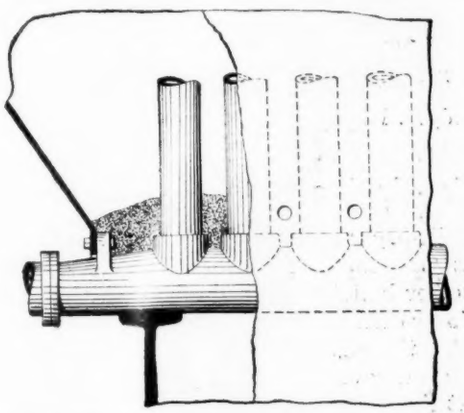
Probably some form of liquid fire extinguisher would be superior to CO_2 as the gas would have only a slight cooling effect on any large mass of hot insulation and metal, although it might be of value where the fire is not extensive and the use of water would cause more damage. If the fire is large and all openings can be closed, the gaseous products of combustion should be just as good as drum gas as an extinguisher, unless large quantities of the latter are used.

C. H. WOODHOUSE.

Prince Albert, Sask., Canada.

Cleaning Deposit from Economizers

We find in working economizers that the soot comes off the tubes and the flue ash lodges at the base of the tubes and prevents the correct working of the scrapers, necessitating occasional cleaning from the inside, which can be done only when the machine is practically cold,



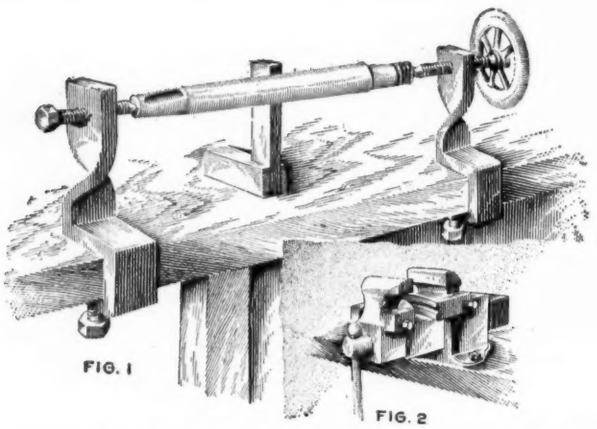
CLEANING HOLES IN CASING AROUND ECONOMIZER

and it is always a dirty job. To overcome this trouble I drilled 1¼-in. holes in the casing in line with the space between the tubes and about 6 in. above the bottom headers. By means of a ½-in. hooked rod and air or steam jets we can keep the space between the headers always free of soot and in this way get the benefit of the full amount of heating surface. The holes are kept plugged when not in use. VAL WEHRMANN.

New Orleans, La.

Locating and Removing Bends

The illustration shows two kinks that will prove helpful in testing and straightening bent work; the vise jaws can also be used in the same way for bending. Both devices can be made from ⅝ x 2½-in. flat



DEVICES FOR TESTING, STRAIGHTENING OR BENDING

stock formed up from one piece, and the center screws of ⅝-in. machine steel bolts. Any length of stock can be tested for true on these centers, using a square on the bench and revolving the work by hand, or the bend can be chalk-marked for straightening.

The special vise jaws, Fig. 2, are useful for straightening small work, as the curve permits springing the work enough to fully remove the bend, whereas in trying to straighten stock in the plain or parallel vise jaws, it still retains a part of the bend when squeezed flat. When using a bench vise to straighten work, don't forget to lubricate the screw well, and don't try to take the kinks out of large-sized stock, or you may break the jaw or otherwise damage the vise. When the work is too large for the vise, it must be heated at the bend and straightened with blacksmith's sledge and flatter, or with V-blocks and a screw. C. H. WILLEY.

Concord, N. H.

Gas-Engine Flywheel Accident

In a daily-paper account of a gas-engine wreck it is said that "the engineer had just left the machine to enter another building when the big flywheel exploded. The engineer cannot explain how the accident happened. He had shut the engine down as usual and left the room, and in some way or other the engine started again and in a short time speeded up enough to cause the flywheel to break."

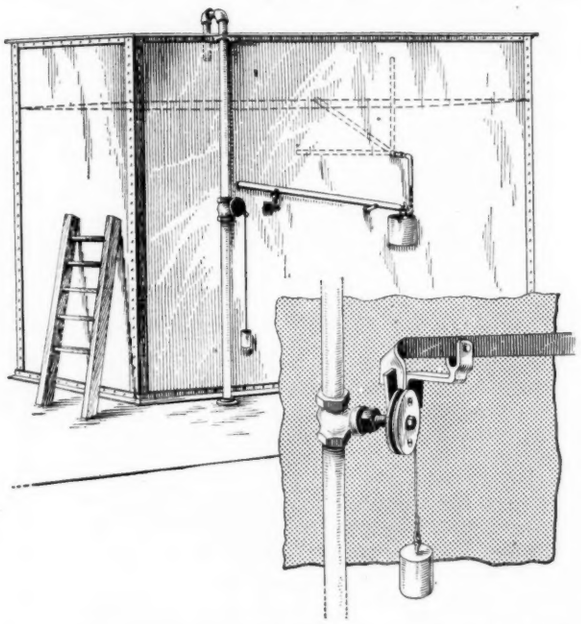
I don't blame him for not being able to explain how the engine could start again after being stopped. Of course there is a reason for the accident, but it could not be given. I have talked with the engineer who was in charge of the engine at that time. He states that everything the engineer wanted he had to go after himself, and on this occasion he was out of drinking-water, so taking his jug he left No. 1 engine room and went through No. 2 to another building where he could get drinking water. He had filled his jug and was coming back when the fireman of the steam section of the plant hailed him, but he noticed that the lights were steadily getting brighter, so he started full speed for his engine, knowing that the governor had gone wrong. He got to the engine and shut off the gas and "beat it" and was out of the plant before the flywheel let go. According to his statement the accident was caused by a bad governor. He claims that it was tied together and tied down with baling wire and on this day one side of the governor came off so it had no control of the gas, taking a full charge every time. The governor had given trouble once before, but the engineer happened to be near the ignition switch and saved the engine that time. He reported it to the superintendent, but nothing was done and the engine had to be run.

The large endless belt that drove the generator caught in the spokes of the broken wheel and pulled the generator off the foundation and damaged it badly. I believe that this accident could have been averted by slight repairs to the governor. R. G. CURREN.

Kittanning, Penn.

Valve Automatically Closes When Tank Fills

The elevated tank in a certain plant had to be filled every morning for the day's supply, and the supply pipe was rather small. This meant a long wait for the engineer while the tank was filling or a return trip, which was sometimes deferred a little too long and an overflow resulted. A different level was also desirable for differ-



OVERFLOW RELEASES WEIGHT TO CLOSE VALVE

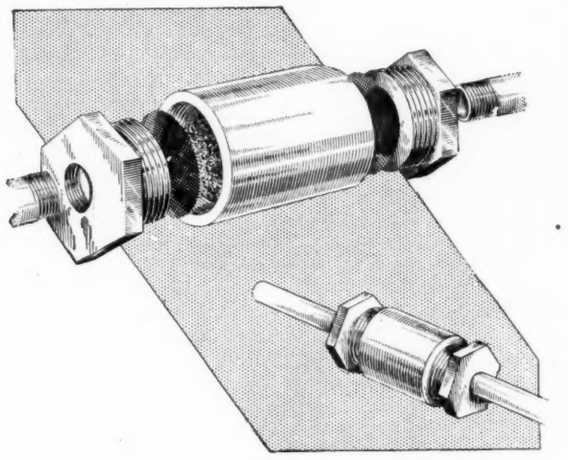
ent processes. The engineer rigged up the device shown in the illustration so that he could simply open the valve, set the stop against it and go about his other duties. When the tank fills to the point at which the small overflow is set, the pail partly fills and trips the catch and the suspended weight closes the supply valve.

The details of construction may be as shown or varied to suit different conditions.

Guttenberg, N. J. L. V. LAUTHER.

Small Pump Strainer

I recently had some interesting experience with a Stanley steam automobile of a type of several years ago, in which there is a tubular boiler 20-in. high by 24-in.



STRAINER ON SUCTION LINE OF SMALL PUMP

in diameter, working under a pressure of 350 to 500 lb., furnishing superheated steam to the engine. The feed arrangement consisted of a hand-operated pump and a small pump operated by the engine. For some time the power pump worked all right when the machine was standing idle, but as soon as it was started on the road the pump would fail to supply the boiler as fast as it should, although the check valves, packing and piping were in good order. Later, when it became necessary to remove the water tank to repair a leak, it was discovered that there had been a fine wire screen over the end of the suction pipe, but that it was broken and at times small particles of wire worked under the pump valves, preventing them from seating. This, with the short stroke and high pressure, prevented the pump from supplying the boiler.

It would have been a difficult job to put a new strainer in the tank, so it was decided to put one in the feed line. The suction pipe was ¼-in. and the strainer was made, as shown, of a 1-in. pipe coupling with a ¼ x 1-in. bushing in each end. Between the ends of the bushings, two fine strainers were placed with hair filtering material between. This strainer eliminated the trouble so far as the pump was concerned.

As an additional boiler feeder a ¼-in. injector was put on as an auxiliary, to be used when the car was standing idle. This injector worked within the range of pressures for which it was designed (from 20 to 160 lb.), but would not work when the pressure reached 200 or 300 lb. Perhaps there are small injectors that will work at such high pressure, but I do not know of any. It is my opinion, however, that a new set of tubes could be made for this injector which would enable it to work with much higher pressure. I would like to know the experiences and views of others and the name of any injector built in small sizes that is suitable for pressures as high as 300 to 500 pounds.

There are several features about a steam automobile that would be interesting to engineers if they could be incorporated in a stationary power plant.

Hyattsville, Md. J. C. HAWKINS.

Copperplating Carbon Brushes

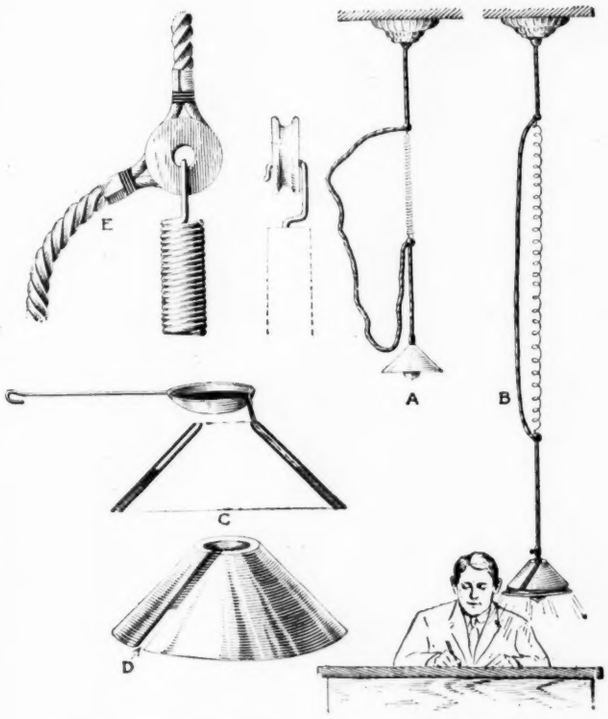
Needing a set of brushes for a 2-kw. exciter and not having any in stock, I made a set by cutting four pieces out of large carbon brushes with a hacksaw, making them the exact length and width but cutting them slightly thicker than the required size. Then with a wooden block and sandpaper I reduced them to the thickness desired. After cleaning, I dipped each brush in a concentrated solution of copper sulphate for a short period, then cleaned and dipped again, the operation being repeated until a coat of copper was deposited, after which it was an easy matter to solder on the pigtail connections. J. W. STANLEY.

Braemar, Tenn.

Adjustable Ceiling Lamp

The illustration gives a method of making an adjustable ceiling lamp that is convenient for desk or bench use where it is desired to quickly adjust the height of the light. Normally, the lamp is held up out of the way by a long spiral spring as at *A*. When it is desired to bring it down near the desk, a weight is placed on the shade sufficient to stretch the spring as shown at *B*.

This weight is made by arranging two lamp shades, of different sizes, one inside the other and pouring the space between them full of lead or babbitt metal, as indicated at *C*. The thickness of the lead should be



PARTS AND ASSEMBLY OF ADJUSTABLE LAMP

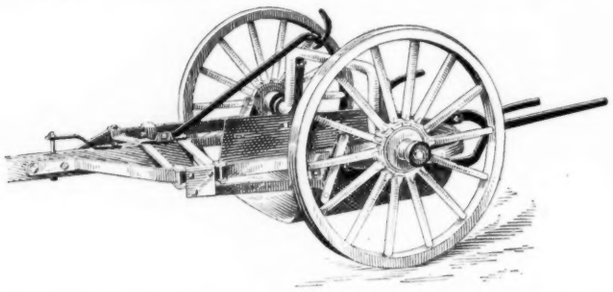
about a quarter inch. After the space between the two shades has been filled with metal, a slot *D* is cut in one side with a hacksaw so that the lamp cord can pass through. The spring is fastened to the lamp cord by porcelain insulators, as shown at *E*.

Ozone Park, N. Y. M. P. BERTRANDE.

Transferring Coal with Scraper

Obtaining labor is a serious problem, particularly about the power plant, and handling coal and ashes is a disagreeable job at the best, so that the solution in our particular case, with modifications, may benefit others.

We have quite a lot of coal stored at a distance from the boiler room, but no conveying system, having depended on cheap day labor, but just now there is



ORDINARY WHEEL SCRAPER FOR TRANSFERRING COAL

no such thing as "cheap labor" and the cost per ton of moving this coal was high. A scraper such as is used for moving earth in grading and excavating was secured, and the work formerly accomplished by six to eight men was done with one man and a horse. The scraper of the type shown in the illustration handles about half a cubic yard at a load.

Richmond, Va. JAMES M. PURCELL.

Silencing a Noisy Motor

In a certain industrial plant exception was taken to the whistling noise of a small induction motor driving an air compressor. Placing a housing over the outfit reduced the noise but little.

By a series of elimination tests it was determined that most of the noise was due to the effect of rough areas on the rotor acting on the ventilating ducts and slots of the stator. Closing the ventilating ducts would not have been a wise procedure on account of increased heating.

As a trial the rotor was removed and the top side of the ends of the rotor bars, where they extend out of the core, were rounded with a file and smoothed with fine emery cloth, and the unfilled parts of the slots of the stator were carefully filled in a manner to make the polar area of the stator a smooth surface. The results were sufficiently satisfactory to qualify the motor for acceptance, and no further complaint was heard about the outfit. E. C. PARHAM.

Brooklyn, N. Y.

An Apparent Overload

In a paper mill it was found advisable to increase the starting torque of a number of synchronous motors by replacing the starting winding with another of higher resistance. After changing one machine and placing it in service, the starting characteristics were found to be entirely satisfactory; but with the same amount of connected load, the machine required, according to the switchboard instruments, 20 per cent. more power to operate it than before the change was made. As there was absolutely no engineering reason why the power absorption should have increased, further tests were made with carefully calibrated portable instruments. These tests indicated that the power consumption was practically the same as before the change was made.

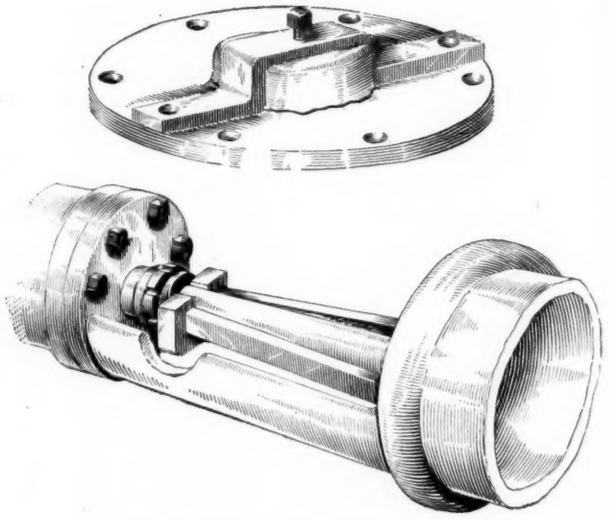
Investigation disclosed that in the interval between the tests, before and after the new starting winding had been installed, one of the switchboard ammeters had in some unaccountable manner been subjected to abuse, the result of which had been to bend its needle so that it indicated 200 amperes high. All of which indicates that too much importance cannot be attached to the care in seeing to it that instruments give correct indications before making the tests. E. C. PARHAM.

Brooklyn, N. Y.

Emergency Pump Repairs

The head on the steam end of a boiler-feed pump was cracked as shown in the illustration. A piece of strap iron, $\frac{3}{4}$ x $1\frac{1}{2}$-in., was put across the head with a $\frac{5}{8}$-in. setscrew in the center. Iron cement completed a permanent repair.

I was called into the mine shaft (300 ft.) to see if I could get the main sump pump, an 18 x 9 x 18 Knowles, to work. The Russian pumper couldn't tell me what the trouble was, but I found that the face of the packing nut on the water end was broken off (probably screwed up too tight). The sump was nearly full and to allow it to overflow would mean that the



TWO DIFFICULT SITUATIONS OVERCOME

mine would be flooded so that work would be out of the question. A piece of 2 x 6 oak was found, and a notched block was made, as illustrated. Two 1 x 3 oak boards were then cut the right length, the block was placed with the slot under the rod and against the face of packing nut, then securely braced with the boards.

This repair held for several days and it saved the company hundreds of dollars until a new packing nut was secured. JACK L. BALL.

Amsterdam, Ohio.

INQUIRIES OF GENERAL INTEREST

Increase of Chimney Capacity for Greater Height—What percentage of additional chimney capacity would be gained by making the height 190 ft. in place of 150 ft.? D. J. C.

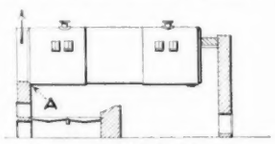
For the same diameter, chimney capacity varies as the square root of the height and hence a height of 190 ft. would have $(\sqrt{190} - \sqrt{150})\ 100 \div \sqrt{150} = 12.4$ per cent. greater capacity.

Removing Scale from Water-Tube Boiler—What treatment can be given for removing lime deposit from a water-tube boiler used for heating? J. A. E.

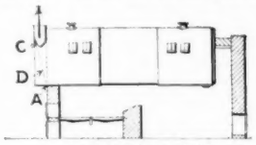
Add to the boiler water about ¼ lb. of soda ash or caustic soda per rated horsepower. Then carry only enough fire to hold about 10 lb. gage pressure for about 48 hours and blow off the boiler when nearly cold. The soda should soften up the deposit so it can be washed out with a hose. Two or three such boilings and washings might be necessary. After the final boiling, the boiler and fittings and connections, especially the safety valve, should be thoroughly washed clean of all traces of the soda. Special care should be taken to wash out the mud drum. If the soda boiling will not remove the scale from the tubes, it may be necessary to clean them by use of a mechanical tube cleaner.

Flush Front vs. Overhung Front Boiler Setting—What are the relative advantages of flush-front and arch-front settings for horizontal return-tubular boilers? L. H.

The principal advantage of a flush-front setting is that it may be regarded as making a better appearance. Its principal defect is the difficulty of maintaining a good seal between the front furnace wall and the water-covered part



FLUSH-FRONT SETTING
FIG. 1



OVER-HUNG SETTING
FIG. 2

of the boiler shell as at the point *A*, Fig. 1, to prevent the escape of hot furnace gases direct to the front connection in place of traversing the full length of the shell and returning through the tubes. In an arch front setting the front smoke connection is formed as in Fig. 2, by extending the boiler shell so as to overhang the arch front, and failure of the seal between the front furnace wall and the shell of the boiler, as at *A*, Fig. 2, can be of no greater harm than to admit air to the furnace. For very low settings the overhang may interfere with the fireman's freedom of access to the fire-door. This objection can be overcome, however, by providing the overhang with a front that slopes upward like the line *CD*, Fig. 2. With an arch front or overhung type of setting, the top of the front furnace wall screens off a little more of the heating surface of the shell than in the flush front setting, but this is more than compensated by requirement of a shorter brick setting, less loss of furnace heat and less annoyance from failure of the front furnace wall.

Measuring Angle of Advance of Eccentric—Having a horizontal slide-valve engine with a direct-connected eccentric rod, how would the number of degrees of advance of the eccentric be measured? L. B.

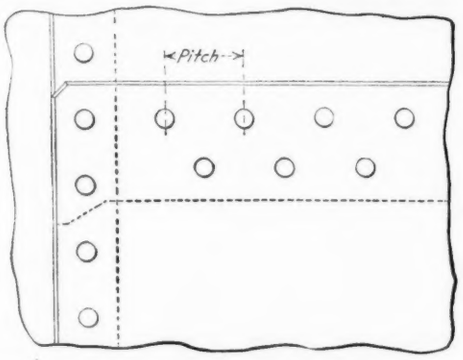
Place the engine on a center and make a mark on the edge of the wheel to correspond with a stationary point, such as a point on a sawhorse placed on the engine-room floor close to the wheel. Then turn the engine backward until a point on the valve rod is at the middle of its travel and make another mark on the edge of the wheel to correspond with the stationary point previously referred to. The distance from point to point around on the wheel will be a measure of the angle of advance of the eccentric. To reduce the angle to degrees, multiply the distance in inches between the marks on the rim by 360 and divide the product by 3.1416 multiplied by the diameter of the wheel in inches, taken at the part of the rim where the marks were located.

Required Size for Governor Driving Pulley—If an 8-in. diameter governor pulley on the shaft of an engine is suitable for regulating the engine speed to 100 r.p.m., what should be the size of pulley to obtain 90 r.p.m. of the engine? R. F. W.

The speed of the governor should be the same when the engine shaft makes only $\frac{90}{100}$ as many revolutions per minute, and neglecting the thickness of the governor belt, the governor driving pulley on the engine shaft would need to be $\frac{100}{90}$ of 8 in. diameter = 8.88, or about 8⅞ in. diameter. For more exact calculation the thickness of the belt should be considered. Allowing the belt thickness to be $\frac{3}{16}$ in. or 0.1875 in., the new pulley should be [100 × (8 + 0.1875) ÷ 90] — 0.1875 = 8.91, or about $8\frac{15}{16}$ in. diameter.

Efficiency of Double-Riveted Lap Joint—What is the efficiency of a double-riveted lap joint made of ⅜-in. steel plate of 55,000 lb. tensile strength, with steel rivets $\frac{13}{16}$-in. diameter after driving, pitched 3 in.? W. R.

Having the thickness of plate ⅜ = 0.375 in., diameter of rivets after driving $\frac{13}{16}$ = 0.8125 in., the cross-sectional area of each rivet would be 0.5185 sq. in. and with pitch of rivets 3 in., tensile strength of plate 55,000 lb. and crushing strength 95,000 lb. per sq.in. of cross-section, for each unit



of pitch of the joint shown in the sketch, there would be

(A) Strength of solid plate,
$3 \times 0.375 \times 55{,}000 = 61{,}875$ *lb.*

(B) Strength of plate between rivet holes,
$(3 - 0.8125)\ 0.375 \times 55{,}000 = 45{,}117$ *lb.*

(C) Shearing strength of two rivets in single shear,
$2 \times 44{,}000 \times 0.5185 = 45{,}628$ *lb.*

(D) Crushing strength in front of two rivets,
$2 \times 0.8125 \times 0.375 \times 95{,}000 = 57{,}890$ *lb.*

As the least strength results from consideration (B) the efficiency of the joint would be,

$$\frac{(B)}{(A)} = \frac{45{,}117}{61{,}875} \text{ or } 72.9 \textit{ per cent.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

American Institute of Electrical Engineers Meet in Atlantic City

THE thirty-fourth annual convention of the American Institute of Electrical Engineers was held in Atlantic City, N. J., June 26-28, with headquarters at the Marlborough-Blenheim Hotel. President E. W. Rice, Jr., opened the convention at 10 o'clock, Wednesday morning. The registration was large even at the opening of the meeting, being about 250 at this time; the total registration for the convention was 355. On opening the convention President Rice, who is president of the General Electric Co., made one of his usual interesting addresses, from which the following excerpts are taken:

President Rice's Address

"The engineer is the hope of the nation, not only now, when we are at war, but even more so in the future days of reconstruction following the great peace.

"There has been no material improvement for several years in the efficiency of electrical units, such as dynamos, motors, transformers, etc. The efficiencies stated in Past President Lincoln's address in 1915, remain almost the same.

"Efficiencies of conversions of mechanical into electrical energy or the reverse—of electrical into mechanical—is still about 90 per cent. in the average case, the efficiency reaching 97 to 98 per cent. in most favorable cases with large units, and falling below 90 per cent. in unfavorable cases. Efficiency of conversion of electrical energy from high to low potential, as in transformers, also remains substantially the same, reaching 98+ per cent. in the largest units. No material change can be expected where such practical perfection is reached. The conversion of the mechanical power of falling water into electrical energy by waterwheels and electric generators has increased from about 87 to 90 per cent. in the largest units of 40,000 hp. This represents about the limit to be expected.

"In the field of thermodynamic engines, represented by large turbo-generator units, some improvement has been obtained. Lincoln stated 75 per cent. of Rankine cycle efficiency had been obtained in large modern steam-turbine units in 1915. This has been increased to about 80 per cent. in the largest units of 35,000 to 40,000 kw., and 75 per cent. is common in practice in moderate-sized units of 10,000 kw. Increase in initial pressure of steam and lowering of terminal pressure contributed to this improvement.

"The following illustrates improvement in efficiency of turbo-electric units, beginning with the first 5000 kw.:

Year	Size	Steam Press.	Superheat F.	Back Press.	Lb. per Kw. Hr.	Per cent. of Rankine Cycle Eff.
1903	5,000	175	0	2 in.	24.00	37.8
1908	14,000	200	125	1½ in.	13.50	66.1
1911	20,000	235	100	1½ in.	13.20	97.0
1913	20 000	200	200	1 in.	10.74	75.9
1916	20,000	250	250	1 in.	10.00	76.5
1917	35,000	230	200	1 in.	10.14	78.7

"It is gratifying to note that a Rankine cycle efficiency of approximately 80 per cent. has been reached. This reflects great credit upon designers of turbo-generators and is a record of achievement found only in the electrical industry. There has been great improvement in boilers, stokers, etc. The progress in case of a combination unit, that is, turbo-generator with its boilers, auxiliaries, etc., has been as follows:

Year	Size of Unit, Kw.	Thermal Efficiency, Per Cent.
1903	5,000	10.15
1908	14,000	15.00
1913	20,000	18.00
1917–1918	35,000	21.06

"For comparison, large gas engines in steel-mill practice under best conditions show 25 per cent. thermal efficiency, but in actual operation an efficiency higher than 18 per cent. to 20 per cent. is rare.

"High-compression oil engines of Diesel type driving electric generators realize 25 to 26 per cent. when new; but this is difficult to maintain. The efficiency must not be confused with much higher efficiencies quoted for gas and oil engines, which refer to indicated horsepower, and not electrical output.

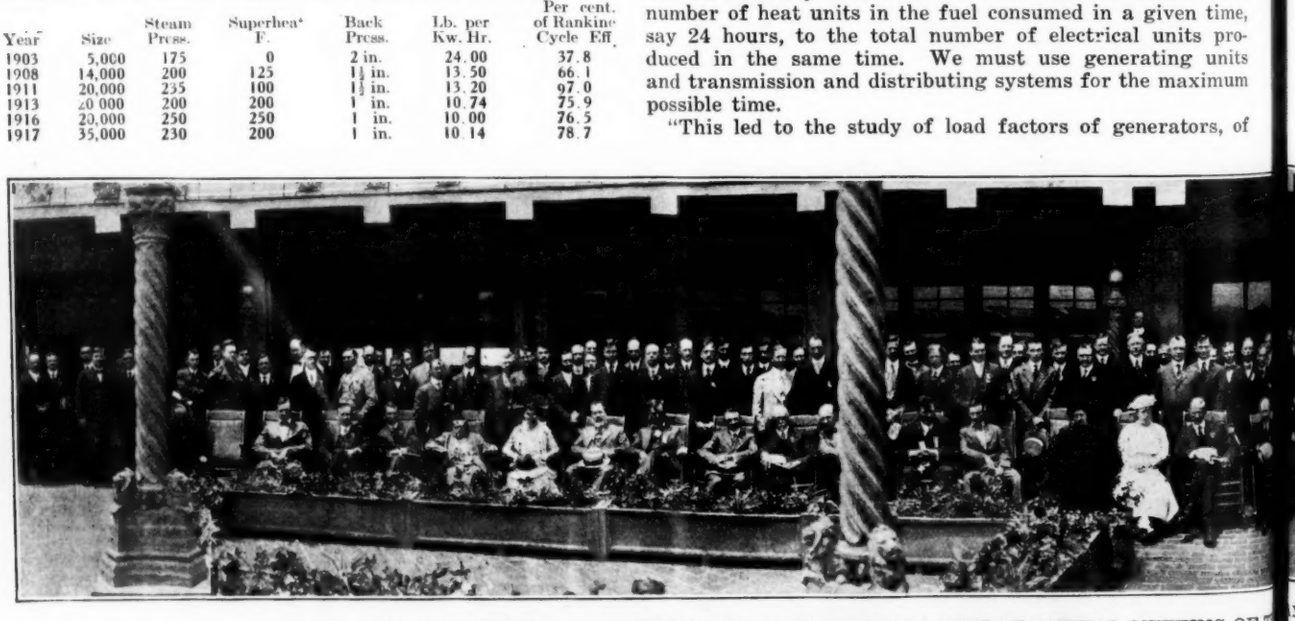
"The steam turbo-electric unit has not reached its highest efficiency. Calculations show that with pressures of 500 lb. gage, a thermal efficiency of 26 per cent. should be easily realized. For further substantial improvement we must look to new methods such as the use of two fluids, as the mercury and steam scheme of W. L. R. Emmet. This method is under development, but is hampered by war work.

"The steam turbine in this country owes its development entirely to the electrical engineer, and this is not surprising, as the electrical engineer was familiar with the advantages of rotary machines, and perhaps it is not too much to say, prejudiced in their favor.

"Progress has been made and is still possible in the generation, transmission and utilization of electrical energy. The struggle for improvement in efficiency has been transferred from the unit to the aggregate, called the system. The system must have units of maximum efficiency, but individual units of high efficiency do not of themselves insure highest efficiency of the whole system.

"To obtain highest efficiency in practical operation the element of time enters as a powerful factor. Our conception of efficiency should consider the relation of the total number of heat units in the fuel consumed in a given time, say 24 hours, to the total number of electrical units produced in the same time. We must use generating units and transmission and distributing systems for the maximum possible time.

"This led to the study of load factors of generators, of



SOME OF THOSE IN ATTENDANCE AT THE THIRTY-FOURTH ANNUAL MEETING OF T

stations and of the system as a whole; to the study of the diversity factor, to reduction of idle currents in alternating-current systems, by the use of synchronous condensers and means for reduction of constant and no load losses in all machinery and transformers, etc.

"Automatic substations for transformers and rotary convertors have come into existence; different power houses of the same system have been tied together electrically; transmission lines of different systems have been interconnected, so that units may be usefully employed for the maximum period or idle or unloaded for minimum time.

"This general development has led to marked improvement in total energy efficiency. Still there is room for further improvement, which will be rapid, owing to the pressure for maximum efficiency in the use of coal and of existing investment.

"All systems are now tied together in California for exchange of power. In Washington and Idaho power systems under different management have had similar change. In the South all important hydro-electric systems have been tied together for exchange of power with better utilization of stream flow, load factor, reliability service; this must bring improvement in efficiency of the system, not only financially, but in a purely technical sense. One of the most important advantages is the obvious reduction of necessary investment in reserve machinery of every description.

"In Montana eight hydro-electric plants are successively using the same stream flow, the total head amounting to 600 ft.; and not only is the natural flow successively utilized, but all the storage water is effectively used by each plant in series. In this system the yearly load factor is 75 per cent. and the mean monthly load factor is 80 per cent.

"Interconnection of hydro-electric plants makes for greater effective use of variation in rainfall, as different watersheds are thereby brought to serve a common system.

"It is estimated that the saving in reserve equipment, improvement in load factor and diversity of different loads useful output of groups of large systems may through interconnection be increased 25 per cent.

"The Standards Committee, created in 1898, has been of inestimable value. The cost of electrical apparatus to the consumer has been greatly reduced, and the quality has not been sacrificed, but improved, due to the committee's work. I consider that the money value of the work so done could be conservatively placed at many millions of dollars.

"Sixty-cycle systems have shown a more rapid growth during the last few years than 25-cycle. Sixty-cycle now represents about 70 per cent. of total power supplied to the country. This is likely due to the lowered cost of transformers, generators, induction motors and similar apparatus. The relative growth of 60-cycle as compared with 25-cycle system is reflected in steam-turbine installations. In 1910 about 60 per cent. of the steam-turbine electrical energy of the country was supplied from 60-cycle machines; in 1917 this had risen to approximately 75 per cent.

"There has been marked progress in electrical furnaces; the number in the United States has increased about 40 per cent. in the last year, and there are now in operation over five times the number that existed five years ago. The world's output of steel from electric furnaces has grown to approximately 4,000,000 tons per annum. It is now possible to produce steel at substantially the same cost as that produced by the openhearth process.

"Electrification of steam railroads is not only economical, but imperatively needed to improve present standards of steam operation. Mountain districts are congested almost entirely by the limitations of steam-railroad systems, and the addition of more tracks is not the best solution of the problem under such conditions. Steam locomotives burn about 25 per cent. of the entire coal mined in the United States, and 12 per cent. of the entire ton mileage movement of freight and passengers carried is represented in cars and tenders required to haul coal to supply steam for locomotives.

"So great is the magnitude of the demand for power by war industries that it is estimated that there will be a shortage of at least 500,000 kw. of electric power in the Eastern district alone.

"Comprehensive schemes are now under consideration which will provide for erection of large steam-electric power stations in the mining regions. By interconnection, present investment and machinery will be better utilized and a large amount of additional electric power made available, without increased demand upon congested railroad facilities.

"All the foregoing is the result of enthusiastic, scientific attack on the inefficient points of the industry, and no other industry measures so near 100 per cent. efficiency."

Professor Adams' Address

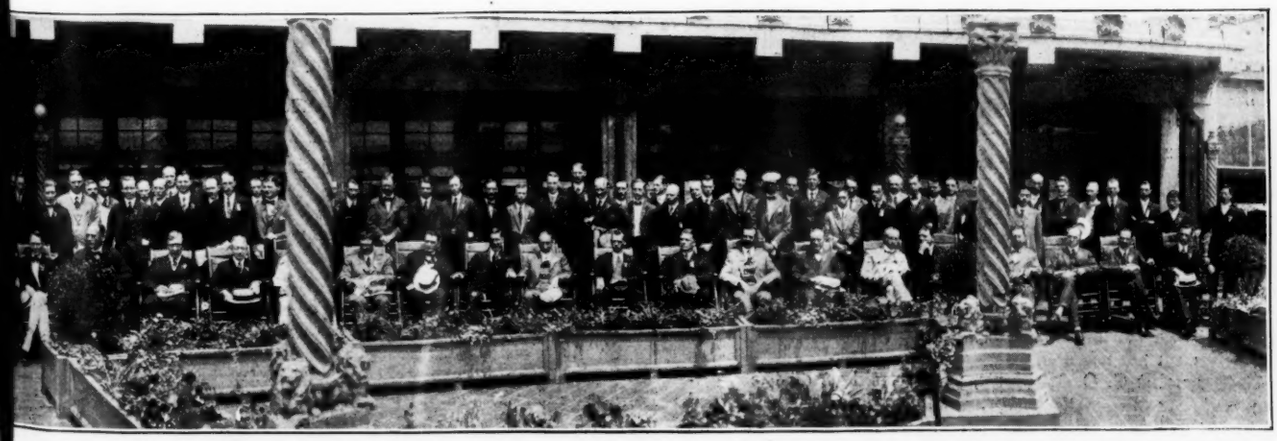
Mr. Rice then called upon the president-elect, C. A. Adams, professor of electrical engineering, Harvard University and Massachusetts Institute of Technology, Cambridge, Mass. Professor Adams spoke briefly, but he stirred those present by his wide vision and keen comprehension of the trend of human affairs as related to the industry. His thought was this: Shall the Institute recognize the new trend in industry, government and the social fabric and participate consciously in their shaping, or shall it stand by passively? It is his judgment that the Institute has its part to perform in these changes and that it should actively participate, and help shape the destinies of the electrical industry and the country.

In responding, President Rice said he was not apprehensive of what was to come when men of the standing and stamp of Professor Adams were the leaders.

Next came the reports of Technical Committees.

From 12:30 to 2:30 p. m. Wednesday the Sections Committee had a luncheon, at which the Institute officers and delegates of sections and branches held a conference.

At 2:30 p.m. the convention again went into technical session, the following papers being read: "Split Conductor Cables—Balanced Protection," by William H. Cole, of the Edison Electric Illuminating Co. of Boston, Mass.; "Aërial Cable Construction for Electric Power Transmission," by E. B. Meyer, of the Public Service Electric



MERICAN INSTITUTE OF ELECTRICAL ENGINEERS, ATLANTIC CITY, N. J., JUNE, 1918

Co., Newark, N. J.; "The Application of Theory and Practice to the Design of Transmission-Line Insulators," by G. I. Gilchrest, of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.

A busy man himself, and therefore regarding time as precious, President Rice unconsciously tends to cut short discussion. This characteristic manifested itself during the discussion of these papers, and members did not talk as freely perhaps as they would have if they felt more at ease.

Following this session the Board of Directors met, and later in the evening an informal reception and dance was held.

Thursday at 10 a.m., C. T. Allcutt, of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., read his paper on "Lightning Arrester Spark Caps—Their Relation to the Problem of Protecting Against Impulse Voltages." Considerable interest in Mr. Allcutt's paper was shown by those present.

Next, Charles E. Stuart, chief of the Power and Light Division of the Federal Fuel Administration, addressed the convention. His talk was in substance the same as published in *Power* of June 25, pp. 927 and 928, and dealt with the measures proposed by the Fuel Administration to economize on coal by its more efficient use in the production of light and power and the utilization of excess water power and interconnection of power systems, both water and steam-driven.

The following papers were then read: "The Oxide Film Lightning Arrester," by C. P. Steinmetz, of the General Electric Co., Schenectady, N. Y.; "The Oxide Film Lightning Arrester," by Crosby Field, Ordnance Department, U. S. A.; "Design of Transpositions for Parallel Telephone and Power Circuits," by H. S. Osborne, of the American Telephone and Telegraph Co., New York City.

The sections' conference was continued at luncheon.

The chief feature of the meeting was the address by General William M. Black, Chief of Engineers, U. S. A. The meeting room was filled to overflowing. The General told of the training of the army engineers, illustrating his talk with motion pictures and lantern slides. Two reels of film showed what the army engineers are doing in France. Nothing other than actually being on the ground in France gives one a better conception of the magnitude of the job the Army, and particularly the engineers, has on hand and how well they are doing it.

General Black said that we must organize for an army of at least five million men and that the execution of this made necessary many more engineers than the army has at present. There is a shortage of engineer officers and enlisted men, and the General urged all to make themselves available to the army. Each one could help the army get the men now so urgently needed, even if he was not himself called into service. The bravery displayed by American engineer troops in France, as told first hand by the General and as related to him by General Haig, of the British Army, is indeed inspiring.

Although the General did not finish his address until a late hour, the following two papers were taken up that evening and were received with unusual interest: "Electric Power for Nitrogen Fixation," by E. Kilburn Scott, consulting engineer, London, England; "America's Power Supply," by C. P. Steinmetz. Mr. Steinmetz's paper is most profoundly interesting. Lack of space forbids including it in this report, and it will therefore appear in another issue of *Power*.

Friday, June 28, the session opened at 10:30 a.m. with a paper by Professor V. Karapetoff, of Cornell University Ithaca, N. Y., on "Pre-Charged Condensers in Series and in Parallel." In this paper Professor Karapetoff suggested the use of the term "daraf," which is "farad" reversed, for the reciprocal of capacity, or elastance. There is precedent for the action, he contended, citing the use of the term "mho," which is ohm reversed.

At this point C. O. Mailloux, past president of the Institute and consulting engineer, New York City, cautioned against the adoption of the term. Mr. Mailloux claimed that Lord Kelvin himself, who was the first, he believed, to use the term "mho," regretted the action later. At least the Germans, in a meeting at Zurich, protested bitterly against the reversal of Ohm's name, charging that it was disrespectful to the memory of Ohm. Mr. Mailloux believes the reversal of Farad's name will bring forth similar protests from the English. Professor Karapetoff replied that he felt it better personally to follow a precedent than to create a new term. He would welcome a term that would apply and that would avoid the reversal of a term name now in use. L. T. Robinson, chairman of the meetings and papers committee, a vice president of the Institute, and engineer for the General Electric Co., here made a plea for some action to smooth out the electrical nomenclature.

An epochal paper presented is that on "Method of Symmetrical Coördinates Applied to the Solution of Polyphase Networks," by C. L. Fortescue, electrical designer, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. This paper, which is highly technical and of great length, is an endeavor to present a general method of solving polyphase network, which has peculiar advantages when applied to the type of polyphase networks which include rotating machines. There were many expressions of praise of this paper, chief among which were those made by C. P. Steinmetz, who said that the paper was of the type that gives dignity and eminent standing to the Institute. Professor Karapetoff and Mr. Mailloux both spoke in high terms of the paper, but each seemed agreed that the subject could be presented in a simpler, less involved form. Mr. Mailloux recommended reprinting the paper, putting the many formulas and worked-out examples and demonstrations in an appendix. The paper is, of course, of most interest to designers of electrical machinery, rather than operators. It may be had by application to the Institute, 29 West 39th St., New York City.

The next paper was, "Sustained Short-Circuit Phenomena and Flux Distribution of Salient Pole Alternators," by N. S. Diamant, of the Rice Institute, Houston, Tex., after which the meeting adjourned for lunch. The sections' conference was again continued.

During the afternoon session the following papers were presented: "Reactance of Synchronous Machines and Its Application," by R. E. Doherty and O. E. Shirley, both of the General Electric Co., Schenectady, N. Y.; "Protection from Flashing for D-C Apparatus," by J. J. Linebaugh and J. L. Burnham, both of the General Electric Co., Schenectady; "The Automatic Hydro-Electric Plant," by J. M. Drabelle, of the Iowa Railway and Light Co., Cedar Rapids, Iowa, and L. B. Bonnett, of the General Electric Co.

Those papers of interest to our readers will be published in abstract in *Power*.

The complete list of officers elected follows: President, Comfort A. Adams, Cambridge, Mass.; vice presidents, Harold Pender, Philadelphia; William B. Jackson, Chicago; John B. Taylor, Schenectady; F. B. Jewett, New York; Allan H. Babcock, San Francisco; Raymond S. Kelsch, Montreal; managers, Frank D. Newburg, Pittsburgh; G. Falcioli, Pittsfield, Mass.; Walter I. Schlichter, New York; treasurer, George A. Hamilton, Elizabeth, N. J.; secretary, F. L. Hutchinson, New York.

Annual Meeting of the American Society for Testing Materials

The twenty-first annual meeting of the American Society for Testing Materials was held in the Hotel Traymore, Atlantic City, N. J., June 25-28. Owing to the press of war work the president, William H. Bixby, was not present. The distinguished secretary, Edgar Marburg, was confined to his bed when the convention opened, and word was received on Thursday that he had passed away. No society ever manifested deeper, silent grief; Mr. Marburg was loved and most highly esteemed.

The first session opened at 10 a.m. Tuesday, with the reading of the minutes of the last annual meeting. The Executive Committee then presented its report. During the year the society published its book of tentative standards of 359 pages. The book is for sale through the secretary's office. The membership of the society is now 2261, of whom

224 are junior members. The total loss of membership from all causes during the year was 175; the net increase was 94. The wisdom of increasing the yearly dues from $10 to $15, as was done in 1916, is shown by the healthy financial condition of the society, there being a surplus of $11,955.53.

The convention was rich in committee reports and papers, there being a total of 57 in addition to oral discussion. Of these the following are of interest to *Power* readers: Revision of Pipe Threads; On Magnification Scales for Micrographs; On Wrought Iron; On Cast Iron; On Corrosion of Iron and Steel; On Magnetic Properties; Grain Size of Iron as Affected by Temperature; Changes Within the Critical Range of a Given Steel; Season and Corrosion Cracking of Brass (this is topical discussion and contains some valuable papers which with others will be abstracted later in *Power*); Report of Committee on Lubricants; Internal-Combustion Engine Lubrication and Lubricants; Electrical Insulating Materials; On Refractories; Necessity for Inspection and Testing of Refractory Brick.

President Bixby, although not able to be present, sent in the following address:

Address by President William H. Bixby

"Of making societies, there is no end." At the recent Pacific Exposition, it was found that there were many hundreds of engineering societies already in existence in the United States, counting engineering associations of all sorts and kinds represented at or recognized by the officials of that exposition.

Civil engineering as a profession is of comparatively recent date. Engineering corps and societies have existed as a branch of the military profession for 500 or 600 years; but as a profession by civilians it is hardly a hundred years old. The first large society of civil engineers in England, the Institution of Civil Engineers, dates back only to about 1828; and the name of "Civil Engineers" was made use of to distinguish its members from the Royal Engineers of the army, which at that time had an engineering society of its own whose membership was restricted to military men. For many years thereafter, there were no technical engineering schools in Europe outside of the military schools. In the United States the West Point Military Academy was established as an engineering academy, to teach all branches of engineering construction, civil and military, over a hundred years ago, and for nearly thirty years it was the only engineering school in the United States. In this connection it should be borne in mind that one hundred years ago, steamboats were in their infancy, railroads were unknown, and electricity as a form of power, light, and heat, and communication, had hardly been dreamt of. Engineering was therefore mainly limited to the construction of highways, canals, buildings, and a limited amount of machinery. Any one desiring to learn engineering as a profession, was obliged to become an apprentice under some local engineer, and his studies were mainly limited to a practice of what his employer was occupied upon at that time. Technical schools were very few in number, less than a dozen, up to about 1860. Today, every self-respecting state of the Union has at least one technical school, academy, college or university. About 1870, there were probably not more than 20 or 30 technical societies of any prominence. Today there are several times that number of societies which might properly be termed "National Societies"; and fully that number of international technical societies; and even at least one association of secretaries of international technical societies. It would seem as if we had almost reached the time when we could begin to consider a reduction in the number of new societies of engineering, rather than a further increase.

It is somewhat to be regretted that more uniformity has not been followed in the titles given to technical societies. It will probably be many years yet before engineering will be fully organized as a profession and before the rank and titles of its associations will be agreed upon.

When engineering societies were first organized, their objects were somewhat different from those of today. In the early days of the society, an important object of its organization was to establish a list of men of engineering experience, as well as to give such individuals an opportunity of becoming acquainted with one another, and of exchanging information regarding the works undertaken or completed by each individual. It was generally expected that when the general public had any large engineering work to accomplish, it would look for engineers among the membership of these societies. Such objects are still important to the engineering societies today, but such importance is becoming less. At an early date, each of the more important societies were obliged to publicly disclaim any responsibility for the correctness of statement made by their members in public addresses or descriptions of engineering work.

As a news disseminator the engineering society has been largely replaced by the daily papers and the weekly, monthly and quarterly scientific journals. As an employment bureau the societies have gradually become loath to discriminate between their own members, except when the call comes from the National Government. As a test of an individual's ability, membership in a society loses value in proportion as the number of members increases; so that it is still just as necessary, as in other matters, to solicit information as to engineering ability from the persons under whom the individual engineers have rendered service, instead of from their engineering societies.

The discussions of engineering questions and their conversion into formulas, specifications or other standards, through the work of committees, are becoming today more and more the most important features of engineering societies. In short, the engineering society of today which is the most important and most useful and most valuable to everybody concerned, is the one which gives the most beneficial results to the general public rather than to the individual member. If the work of any particular society is beneficial to the entire engineering profession and the general public, it will have earned its right to the title "Society," or "Institute"; if it is looking only after benefit to its individual members, the title of "Club" is more expressive and honest. Not until its work is beneficial to the entire engineering fraternity of the United States as a whole, has it any right to call itself a "National" society or association. As a general rule the best work of any individual country can be done by one of its national associations; and an international organization becomes necessary and specially useful only so far as needed to reconcile serious differences between the standards of the various nations concerned.

Importance of Committee Work

One of the most important functions of a society of today, if not the most important, is the work of its committees to influence uniformity of ideas and standardization of methods and constructions. It is because of the predominance of this committee idea in its work that the American Society for Testing Materials has been so successful as a technical society and is being so recognized by the general public and the Federal Government. We have already 39 main committees and over 130 subcommittees, all busied with important studies and decisions. Few other engineering societies in the country, if any, show as many committees and as good work therefrom. I consider a large part of the success of our committee work is due to the unflagging industry, unusual enthusiasm and good judgment of our secretary, whose absence from this meeting we greatly regret and for whose speedy recovery we extend our best wishes. Many committees in other societies have failed to secure the best results because they have failed to realize the importance of the essential rule laid down by our society, that both sides of every subject treated must be represented in the committee room, and that the matter at issue must be threshed out by the committee until both sides are willing to admit that the final recommendation is the one most advantageous to the interests of the two sides taken together.

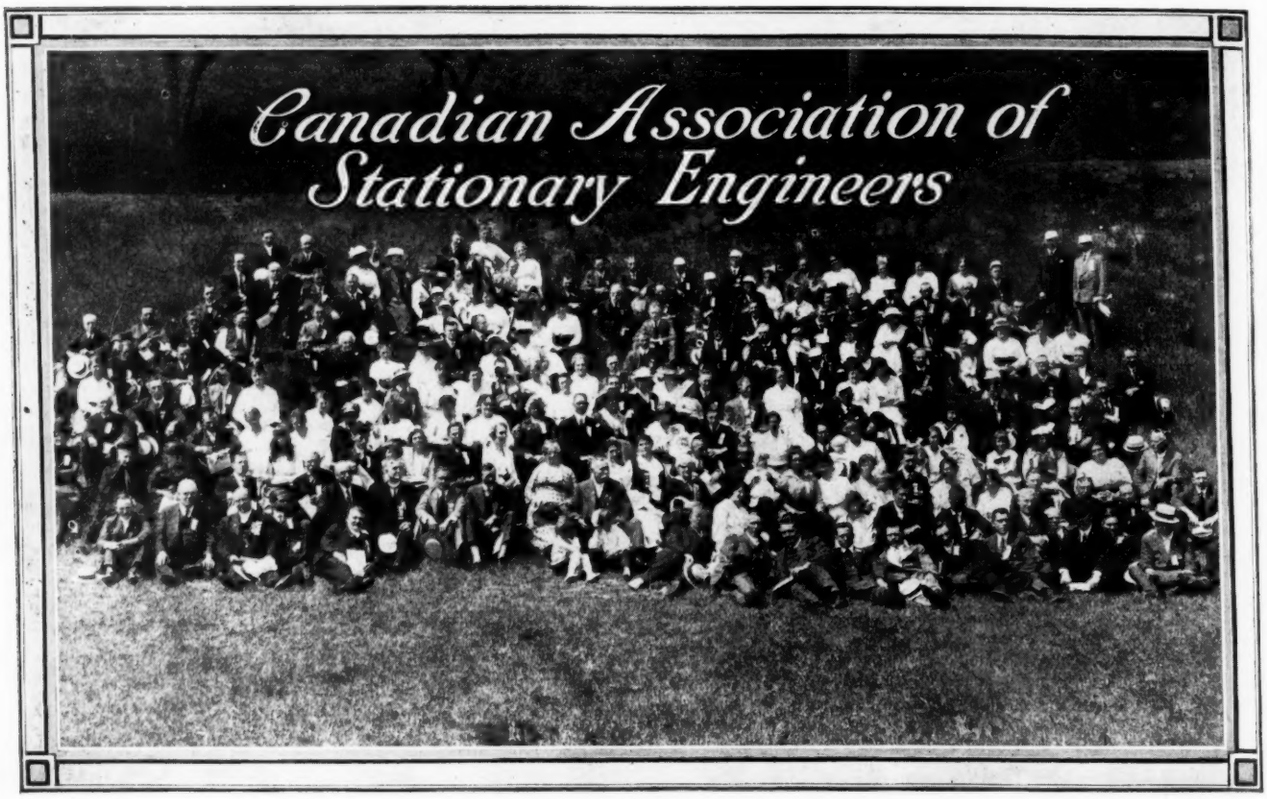
One of the features of the meeting was the topical discussion on Industrial Research, to which men particularly well qualified contributed, there being half a dozen papers presented.

Thursday afternoon the golf tournament was held; but the wind blew so hard that good golf was impossible.

The number registered was 400.

The following officers were elected: President, Guilliam H. Clamer, vice president, Ajax Metal Co., Philadelphia; vice president, George S. Webster, Director Wharves, Docks and Ferries, Philadelphia; members of the Executive Committee: Guilliaem Aertsen, Midvale Steel Co.; G. K. Burgess, Bureau of Standards, Washington, D. C.; G. B. Heckel, editor, *Oils, Drugs and Paints;* and K. W. Zimmerschied, metallurgist, General Motors corporation.

The Executive Committee drew up resolutions on the death of Secretary Marburg, a copy being sent to his relatives. A new permanent secretary has not been appointed at this writing.



PICNIC AT PORT STANLEY, JUNE 26, IN CONNECTION WITH THE TWENTY-NINTH ANNUAL CONVENTION AT LONDON

THE twenty-ninth annual convention of the Canadian Association of Stationary Engineers was held in London, Ont., June 25-27, with headquarters at the Tecumseh Hotel. There were fully one hundred engineers present, which is the largest attendance in many years.

Hyman Hall, conveniently situated from the headquarters, was the place of meeting of the delegates. The main hall of this building was arranged for the mechanical display of power-plant equipment by the Canadian Exhibitors' Association; there were thirty firms represented.

At the several sessions many important measures conducive to the welfare of the organization were discussed. Great satisfaction was expressed at the introduction of graded engineers' certificates. These will be divided into first-, second-, third- and fourth-class certificates, and will be interchangeable between the provinces. A system of this kind has long been desired by the engineers. It will give an impetus to the educational features of the organization and will create a tendency on the part of the members to secure first-class certificates, which can be procured only by passing a practical examination before a competent board of examiners, and will also necessarily raise the standard of engineers of Canada. It is expected that there will be a big increase in the membership during the coming year, as several requests for charters have lately been received, and a further effort in this direction will be made. The reading of the secretary's report showed that the organization is financially sound.

The opening ceremonies took place at 10 o'clock on Tuesday morning, with the executive chairman, Roger F. Gofton, of Kitchener, occupying the chair. He told the gathering that the engineer of the future would be required to have a much higher efficiency and urged the delegates to take advantage of the education offered by the association, to read the technical journals and to obtain knowledge through every other channel of education. Mayor C. S. Somerville heartily welcomed the visitors to the city and was thanked by the chairman. In the absence of Lieutenant Archibald, president of the Exhibitors' Association, who is a prisoner in Germany, the secretary of that organization, Gordon C. Keith, thanked the local committee for its able help in completing the arrangements for the convention. F. R. Low briefly outlined the fuel situation and explained the need for the extreme conservation of coal. Ephraim Valiquet, chairman of the Board of Examiners of Quebec, spoke of the good results of the graded certificate in his province. Speeches were also made by William G. Walters, Samuel Balmfirth, "Dad" Wickens, Calvin B. Turner and Jack Armour. The secretary read a telegram from John A. Wickert, of Milwaukee, Wis., president of the National Association of Stationary Engineers, who expressed his regrets at not being able to attend owing to important business engagements, and said that the N. A. S. E. would be ably represented by Fred W. Raven, its secretary, who would be present. At this juncture the convention went into executive session, and after the necessary committees were appointed an adjournment was taken until the afternoon session at 2 o'clock.

On Tuesday evening special cars conveyed the company to Springbank Park, where an appetizing dinner was served and a pleasing entertaiment enjoyed.

On Wednesday afternoon the convention was treated to an outing at Port Stanley. A program of games and outdoor sports of many kinds was conducted by Calvin B. Turner and George E. Moll. There were suitable first and second prizes to the winners in each event. The ladies were largely in evidence in the sports. A baseball game between the engineers and supplymen was won by the former by the score of 14 to 10. At 5 o'clock a war dinner was served in the dancing pavillion, after which the special cars were boarded for London.

On Wednesday evening at 8 o'clock an entertainment was given in the exhibit room at Hyman Hall. In opening the proceedings Gordon C. Keith, the master of ceremonies, called to the stage Dr. R. A. Riddell, F. R. Low, Fred W. Raven and A. M. Wickens, who were made honorary members of the grand lodge, the exercises being performed by the executive president, Roger F. Gofton. Dr. R. A. Riddell, superintendent of the Trades and Labor Branch of the Ontario Department of Public Works, read an important document explaining the value of the graded certificates to the engineers of Canada. Fred W. Raven, of Chicago, secretary of the National Association of Stationary Engineers, gave an interesting address of special interest to engineers. F. R. Low briefly and emphatically referred to the immense activities in the United States to-

ward winning the war. W. C. McGhie, chairman of the Engineers' Board of Ontario, told of the improvement in the quality of the engineers in the last few years. E. F. Valiquet, chairman of the Engineers' Board of Examiners of Quebec, emphasized the speech of Dr. Riddell regarding the graded certificates. E. A. Heatherington sang songs and Jack Armour told stories which were greatly appreciated. A local orchestra enlivened the occasion, and solos and duets were sung by local artists. The distribution of prizes brought a most enjoyable night to a close.

At the closing session on Thursday morning a resolution was unanimously adopted recommending reciprocity licenses between the United States and Canada. The following grand officers were elected: R. F. Gofton, Kitchener, past president; William M. Cooke, Belleville, president; George E. Moll, London, first vice president; I. J. Tait, Montreal, second vice president; Daniel L. Webster, Brantford, third vice president; John H. Hale, Hamilton, secretary; Alfred W. Heath, Hamilton, treasurer; Charles Berry, Ottawa, conductor; A. R. Taylor, Toronto, doorkeeper.

At the final meeting of the Exhibitors' Association the following officers were elected: Lieut. Lloyd Archibald, Toronto, past president; C. N. Schrag, Toronto, president; James Mock, Montreal, first vice president; Calvin B. Turner, Toronto, second vice president; B. G. Newton, Toronto, treasurer; L. H. Rumage, Buffalo, assistant secretary; Arthur Belton, Toronto, chairman exhibit committee; H. Ramshaw, Hamilton, chairman reception committee; Bertram Curzon, Montreal, chairman entertainment committee.

The Ladies Auxiliary elected officers, as follows: Mrs. W. A. Sweet, Hamilton, past president; Mrs. W. G. Blackgrove, Toronto, president; Mrs. G. W. Fowler, Toronto, vice president; Mrs. Charles Hooper, Toronto, secretary; Mrs. Edward Grandbois, Chatham, treasurer; Mrs. Charles Ott, Kitchener, conductor; Mrs. A. W. Heath, Hamilton, doorkeeper.

Fred W. Raven presented to the Grand Council, in behalf of the National Association of Stationary Engineers, a handsome silk American flag. Gordon C. Keith was presented a silver service, the gift of the supplymen. Roger Gofton received a past president's jewel. George E. Moll was presented an umbrella, the gift of the exhibitors.

Samuel Balmfirth, of Toronto, was elected a delegate to the N. A. S. E. convention at Cincinnati, Ohio, next September. This is the first time the Grand Lodge has appointed a delegate to the United States. Brantford was selected as the next convention city, June 23-26, 1919.

Semiannual Meeting of the A. S. H. V. E.

The semiannual meeting of the American Society of Heating and Ventilating Engineers was held at Hotel Statler, Buffalo, N. Y., June 26-28. The opening session was addressed by Mayor Buck, welcoming the delegates, and response was made in behalf of the society by H. G. Issertell. President Still followed with appropriate remarks outlining the work undertaken by the society in connection with the country's great work in carrying on the war. The annual reports of chapters, outlining their activities and growth followed. The society contemplates establishing a Research Bureau, and a committee appointed at a previous meeting reported favorably upon its feasibility and the probable amount of funds necessary to carry on the work—not less than $10,000 per year for a period of at least five years. The committee appointed to confer with the Bureau of Mines and the Fuel Administration on the apportionment of coal for domestic users also made a preliminary report. Full and final reports are received and acted upon at the annual meetings only. A paper on "The Electric Method of Testing Radiators," by Prof. J. E. Emswiler, of Ann Arbor, Mich., brought out some discussion and many questions. The paper is published in full in the July issue of the *Journal* of the society; all of the papers discussed appear in either the April or July *Journal*. The afternoon session was devoted to two papers—"The Heat Transmission of Standard Building Materials," by A. C. Willard, and "Ventilation of Mines," by Thomas Chester—and topical discussions including the use of independent heater units for factories, warehouses and large interior spaces, and open-window ventilation of schools.

The morning session Thursday was devoted to papers and discussion on dehydration of fruit and vegetables as a means of feeding the nations and winning the war. Addresses by Dr. H. C. Gore and Professor Cross, of the United States Department of Agriculture, and a paper by W. A. Perry and W. L. Fleisher were followed by questions and discussion. The afternoon session was held at the Buffalo Canoe Club, Abino Bay, where dinner was served later. Four excellent papers were presented. The first by Prof. J. D. Hoffman, 'Reasons for Failures of Heating Systems," was followed by two by C. W. Baker, "A Campaign for Fuel Economy in House Heating" and "Reforms in the Design of Hot-Air Heating Plants," and along the same lines "Economy in Heating," by Konrad Meier.

At the closing professional session Friday morning four papers were read and discussed. "Spontaneous Combus-

DELEGATES AND GUESTS AT THE SEMIANNUAL MEETING A. S. H. V. E., BUFFALO

tion," by Dr. M. W. Franklin; "Notes on Spontaneous Combustion of Coal," from the Bureau of Mines; "Heating the Base Hospital at Camp Dodge," by P. M. O'Connell; "Duty of the Employer in the Reconstruction of the Crippled Soldier," by D. C. McMurtrie. The topical discussion of "Fuel Consumption Required for Operation of Air Washers" was limited for lack of time.

A committee on publicity was appointed, consisting of Arthur S. Armagnac, Frank K. Chew and James D. Hoffman, to bring educational matter along the lines of the activities of the society before the general public.

Engineering Educators Discuss Student Shortage

How to meet the increasing demands for engineers to carry on the war and industry now and to provide for the reconstruction period, were the impelling motions back of much of the discussion at the convention of the Society for Promotion of Engineering Education, held June 26-29 at Evanston, Ill. Prof. C. R. Mann, who outlined the forthcoming report of the Joint Committee on Engineering Education and also the latest decisions of the Government with reference to students' training camps, was the center of debate nearly the whole of one day. During the evening session engineers of the Western Society of Engineers and sections of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers added their views, a joint meeting being held for the purpose of getting the opinions of the practicing engineer.

W. L. Abbott, chief engineer, Commonwealth Edison Co., detailed the methods by which the public-service companies recruited engineers. Formerly, a young graduate was put to work at $2 per day with the gang. At the end of the year the man might still stick, but not from any effort on the part of the company. His trustworthiness and eagerness to take responsibility were about the only things that would bring him to the attention of the employer. That day passed some years ago, as the recruits failed to materialize. This reluctance on the part of men to seek work was progressive from East to West, and finally the Central Station Institute was founded, in which 30 to 50 were trained for a year. A charge of $400 a year was made and the men were paid $40 per month for the part time spent in the different departments. In four years 85 graduated, one-half of whom stayed with the company until the war began, when 80 per cent. left, practically terminating the experiment.

Now the scheme is to give the men a large part of preliminary work in five vacation periods while at school; only one-half day a week is given to classroom study. The pay is $60 to $90 per month. As before, the men are shifted often from one department to another. The latter is a serious drawback because department heads are not enthusiastic about training greenhorns charged up to them only to have the new man transferred when he is ready to do productive work. Taking the men during vacation works so well Mr. Abbott is of the opinion it would be well to put them on during the freshman year and possibly from high school. Just at present the Government is combing out the lists and he believes this is a mistake for if men had stuck out their full course we would now have thousands of graduates well equipped to handle the necessary war industries clamoring for them.

In the address of the president, Milo S. Ketchum, read by John F. Hayford, on "Essentials in Engineering Education," it was stated that the most critical problem in engineering education today is to obtain a sufficient number of competent teachers. No greater task can be undertaken by the society, in his opinion, than to improve the conditions and increase the emoluments of engineering teachers so the engineering students may all have instruction under men of thorough training in theory and practice who can comply with the specifications for a good engineer. Other statements were to the effect that one of the most important advantages gained from technical education was contact with other men and an appreciation of the value of human engineering.

Power-Plant Efficiency Campaign

The United States Fuel Administration announced June 27 the appointment of Henderson W. Knott to manage the field force of engineers and inspectors which is at work among the power plants of the country, carrying out a campaign of instruction and inspection designed to bring the use of fuel for the production of power to the highest possible efficiency and economy.

Mr. Knott has been the general manager of the Morgan Crucible Co. of New York City. His appointment is a part of the plan originated by David Moffat Myers, advisory fuel engineer of the Fuel Administration, to have each of the 250,000 steam plants in the United States visited by a competent man who can make suggestions and report in connection with the questionnaire originated by Mr. Myers, working with committees from the four great engineering societies. This field force will be organized by states in order to give it greater force and efficiency. Many of the state heads who work directly under the State Fuel Administrators have already been appointed and Mr. Knott, cooperating with Mr. Myers, will complete the list of state appointees, and will visit the states already organized to study the work being done by the men in the field and to speed up the inspection program.

The Fuel Administration announced June 28 the appointment of administrative engineers as follows: Thomas R. Brown, Pittsburgh, for the western half of Pennsylvania; George R. Henderson, Philadelphia, for the eastern half of Pennsylvania; Edward N. Trump, New York, for the State of New York; W. R. C. Corson, Hartford, for New England. These engineers, with others who are awaiting formal appointment, are in Washington in consultation with officials of the Fuel Administration in charge of conservation. Others attending the conference, which will go on for several days, are: M. S. Hopkins, Columbus, Ohio; O. P. Hood, chief mechanical engineer of the Bureau of Mines, Pittsburgh; Prof. H. P. Breckenridge, Yale University, and H. H. Stoek, professor of mine engineering, University of Illinois.

The system extends into all states east of Mississippi River, and all of Louisiana, Missouri and Minnesota. In laying the foundation for the organization—work which has been in progress for many months—it has been anticipated that this work will be a permanent service of the Government. From 10 to 20 per cent. of the coal now used can be saved by correct operation of the steam-power plants, using their present equipment, and without the delay or expense involved in the installation of new or improved apparatus.

State Fuel Administrators, in their judgment, may entirely or partially shut off the consumption of coal by any needlessly wasteful plant in their territory.

Inspectors are furnished from one or more of the following sources: (a) Inspectors of steam boiler insurance companies; (b) state factory inspectors; (c) engineering students from technical colleges; (d) qualified volunteers.

In this campaign of practical accomplishment the slogan of the Fuel Administration is "Maximum Production with Minimum of Waste," the object being to operate all industries at full capacity, but at the same time to make every pound of fuel perform its maximum service in power, light and heat.

High-Tension Lines Completed

The Southern Canada Power Co., Ltd., has completed its high-tension transmission lines with the necessary substations connecting the cities of Sherbrooke and Granby, Que. The line, which is of 48,000-volt capacity, passes through the towns of Magog, Knowlton, Foster and other places and is now in operation, supplying Granby and the intervening points with electric power.

Work on one of the company's large hydro-electric developments at Drummondville, Que., is progressing satisfactorily, over 250 men being employed. The plant will have an ultimate capacity of 17,000 hp. and it is anticipated that two units with a capacity of over 7000 hp. will be in operation by April next. Additional high-tension lines connecting Drummondville with Sherbrooke are being built.

Obituary

Frank J. Corbett, for many years a representative of the Ashton Valve Co., of Boston, and lately vice president and secretary of the Bergen & Linderman Co., 30 Church St., New York City, died in his 48th year, at his late residence, 171 Midwood St., Brooklyn, on Tuesday morning, July 2. He had been in ill health for the past nine months. He was a member of the New York "Bunch" of entertainers, and was widely known in engineering circles. The funeral services took place at his late home on Wednesday, July 3. Mr. Corbett is survived by a widow.

Personals

A. Niedermeyer, for many years connected with the Worthington Pump and Machinery Corp., recently as works manager of the Snow-Holly Works of that corporation, at Buffalo, N. Y., resigned on May 31 to devote his entire time to enterprises of his own.

Harry A. Ellard, who was for many years connected with the New York & Queens Electric Light and Power Co., Long Island City, as assistant superintendent of operation, has accepted a position as chief engineer of the Mercer and Trenton Traction Corp., Trenton, N. J.

A. B. Cole has been appointed assistant to manager, Department of Publicity, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., to succeed M. C. Turpin, who is now in the Ordnance Department at Washington, D. C. Mr. Cole has been connected with the Westinghouse Co. since 1909.

John J. Calahan, supervising engineer, Board of Education, Jersey City, N. J., and well known in N. A. S. E. circles, has been appointed one of the instructors in the new school of marine engineering of the United States Shipping Board, Recruiting Service. The courses in marine engineering will be given in the Dickinson High School.

W. A. Haines has been appointed district representative at Detroit, of the automobile equipment department of the Westinghouse Electric and Manufacturing Co. Among the automobile manufacturers of the Detroit district Mr. Haines is well known through his service for some years as assistant district manager of that department of the Westinghouse Co.

Dwight P. Robinson and **John W. Hallowell** have retired from the firm of Stone & Webster, and the business will be continued by the remaining partners, Charles A. Stone, Edwin S. Webster, Russell Robb, and Henry G. Bradlee. Dwight P. Robinson has been with Stone & Webster since 1893, from 1908 president of the Stone & Webster Engineering Corp. and a member of the firm since 1912. John W. Hallowell has been with Stone & Webster since 1901 and a member of the firm since 1912. Since May, 1917, he has been in Washington with Mr. Hoover as a member of the United States Food Administration and expects to continue in that work for the duration of the war.

Engineering Affairs

Texas State Association N. A. S. E. will hold its annual convention at Dallas, August 5-7. The arrangements are near completion and the committee expect a successful meeting.

New England States Association N. A. S. E. will hold its annual convention at Bridgeport, Conn., July 10-13. The Stratfield Hotel will be the headquarters. The New England Association of Commercial Engineers will hold its display of power-plant supplies and equipment at the State Armory. It is expected that all available space will be taken. The committee is confident of a rousing convention.

The Compressed Air Society, acting upon the recommendation of its Technical Committee, has adopted the following definitions of certain compressed-air terms in order to eliminate confusion as to their exact meaning: Displacement of an air compressor is the volume displacement by the net area of the compressor piston. Capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction. Volumetric Efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above. Compression Efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder as shown by indicator cards, and may be expressed as the product of the volumetric efficiency, the intake pressure and the hyperbolic logarithm of the ratio of compression, all divided by the indicated mean effective pressure within the air cylinder or cylinders. Mechanical Efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a steam-driven, and to the brake horsepower in the case of a power-driven machine. Over-all Efficiency is the product of the compression efficiency and the mechanical efficiency. The society further recommends that the use of other expressions of efficiency be discontinued.

Miscellaneous News

Salary Increases for Federal boiler inspectors are authorized in a House bill passed June 18 by the Senate without amendment. It now goes to the President. New salaries are fixed as follows: Chief inspector, $5000 annually; assistant inspectors, $4000; district inspectors, $3000.

Watch Officers—One thousand experienced seamen are being prepared in the Shipping Board navigation schools for watch officers. Men between 21 and 30, inexperienced in seagoing, are being accepted by the Shipping Board on its merchant-marine training ships at Boston. There are many opportunities for men to become firemen.

Utilization of Water Power in Italy.—A noteworthy increase took place in 1917 in the utilization of Italian water power, according to "Commerce Reports." The total power of all concessions in June, 1916, amounted to 1,060,000 hp. and in December, 1917, there were 218 requests for concessions estimated at 816,147 hp. in course of examination.

Merged Utilities Companies—Acting on the recommendation of Mayor W. J. Black, the city Board of Works has effected a consolidation of Anderson's (Ind.) two municipal properties, the light plant and water plant. The consolidation was effected June 15, and James J. Netterville was named as the general manager of the unified plants. The board, in carrying out the mayor's wishes, also decided to drop seven of the present employees of the two plants, cutting down operating expenses to the amount of $5100.

American Goods Wanted for Australian Market—Walter E. Bush, 109 Highland Avenue, Jersey City, N. J., has recently been appointed United States buyer for one of the largest importing corporations in Australia. If any readers are not now represented in that market and if their goods are manufactured by and their firm is composed of non-enemy aliens a large amount of business might be secured for that field, which at this time is more than ever looking for goods of American manufacture, by corresponding with Mr. Bush.

The Colonial Power & Light Co. and the Claremont Power Co., which are operated by the W. S. Barstow & Co., are doing everything possible to release able men for military service. Wherever possible, crippled men have been given the preference and work has been found to suit them. At the Cavendish, Vt., power house one of the load dispatchers is a man with but one arm. He is able to perform his duties fully as well as though he had both arms. In the Claremont, N. H., power house is a lame man who makes an efficient operator. Both companies have taken the employment of women into consideration. One is acting as load dispatcher in Cavendish and another is reading meters in Claremont and Springfield, N. H. Both have given satisfaction, and the companies no longer fear employing them on the grounds of inefficiency.

Profiteering in Coal—Approximately 200 cases involving violations of its orders have been referred by the United States Fuel Administration to the Department of Justice for prosecution. A large majority of the offenders in these cases are jobbers who have made a profit in excess of that prescribed by the Fuel Administration. There are other cases in which operators have charged more than the government price for coal. In some instances the charges complained of were made by mistake. In a majority of cases, however, the overcharges were apparently made intentionally in the expectation that they would escape the attention of the authorities. The Fuel Administration is determined to enforce its orders. There are between four and five hundred cases involving violations now under consideration by the legal department of the Fuel Administration. The cases of those who fail or refuse to comply with the demands of the Fuel Administration will be referred to the Department of Justice for prosecution.

New Construction

Proposed Work

N. H., Nashua—The New England Power Co. has petitioned the city council for the right of way to erect an electric transmission line to supply electricity to the Nashua Manufacturing Co., Mine Falls, N. H.

Mass., Sherborn—The Sherborn Reformatory for Women is having plans prepared for the erection of a large power plant. Estimated cost, $70,000.

Conn., Coscob—Lockwood, Green & Co., 101 Park Ave., New York City, is receiving bids for a 4-story, 42x145 ft. rein.con. dyehouse for the Mianus Manufacturing Co., 615 4th Ave., New York City. The company will install steam heat and boilers. Total cost, $40,000.

Conn., New London—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install electrical equipment in its power plant here. Specification No. 2965.

N. Y., Akron—R. J. Reidpath, Engr., Builders' Exchange Building, Buffalo, will soon receive bids for the erection of a 1-story, 45 x 75 ft. power plant, here, for the Wheat Ice Cream Co., Buffalo. Estimated cost, $35,000.

N. Y., Buffalo—The Pullman Co., Marine Bank Bldg., has had plans prepared for a power house to be erected at 1770 Bway. Estimated cost, $27,000.

N. Y., East Rochester—The Merchants Dispatch Transportation Co. will receive bids during summer for an addition to its power plant. R. Yates, Engr.

N. Y., Galway—The Saratoga County Homestead Sanitarium has had plans prepared for the erection of an addition to its power plant. Estimated cost, $12,000.

N. Y., New York—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install electric lighting and power system here at shipbuilding Slip 2. Estimated cost, $20,000.

N. Y., New York—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install electric driven capstans here. Specification No. 3172. Estimated cost. $21,000.

N. Y., New York—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until July 22 for the installation of an electric power system in its structural shop here. Specification No 3131. Estimated cost, $25,000.

N. Y., New York—J. Katz, 51 Chambers St., is having plans prepared for a 4-story, 34 x 92 ft. garage at 325 East 9th St. and will install steam heat and boiler in same. Estimated cost, $30,000. C. B. Meyers, 1 Union Sq., Arch.

N. Y., Niagara Falls—The United States Light and Heat Corporation has had plans prepared for an addition to its plant at 3215 Highland Ave.

N. Y., Watertown—The city is having plans prepared for the erection of a 1-story, 90 x 120 ft. electric plant. Estimated cost, $175,000. T. L. Tomlines, City Bank Bldg., Syracuse, N. Y., Engr.

N. Y., Yonkers—G. H. Chamberlain, Arch., 18 South Bway., is receiving bids for the heating system to be installed in the nurses' home of the Yonkers Homepathic Hospital, 127 Ashburton Ave.

N. J., Bayonne—The Associated Industry of Bayonne has had plans prepared by Shattuck & Hussey, Archs., 19 South La Salle St., Chicago, Ill., for a recreation building to include lighting and ventilating systems.

N. J., Burlington—The State Masonic Home, Jacksonville and Oxhead Rds., is having plans prepared for a boiler plant.

N. J., Hopewell—The Borough plans to install electrically driven pumping equipment at its waterworks.

N. J., Kearny—The State House Comn., Trenton, has appropriated $12,500 for the purchase of 2 new boilers for the Soldiers' Home, here.

N. J., Newark—The Board of Freeholders, Essex Co., will soon award the contract for the erection of a power house and laundry, to include electrical wiring, heating plant, etc.

Penn., Nicetown—The Midvale Steel and Ordinance Co. plans to install 27 electrically driven cranes, as follows: five 100-ton, one 75-ton, eight 50-ton, one 30-ton, three 25-ton, eight 10-ton and one 5-ton.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install 4 boilers in naval hospital here. Specification No. 3180. Estimated cost, $18,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install electric driven capstans here. Specification No. 3172. Estimated cost, $21,000.

Ind., Tipton—City plans to sell $22,000 bonds to repair and install new machinery in its light and water plant. B. Graham, Engr.

Wis., Janesville—The State Bd. Control will soon award the contract for the installation of heat and an electric system at the State School for the Blind. A. Peabody, Madison, Arch.

Wis., Superior—The Great Northern Power Co. has been granted a right of way to erect a 22,000 volt transmission line. W. N. Ryerson, 15th Ave., West and Superior Sts., Duluth, Minn., Ch. Engr.

Iowa, Schaller—The council plans to issue $30,000 bonds to install an electric light plant.

Minn., Mahnomen—H. S. Richer has had plans prepared for enlarging his electric light plant.

Kan., Baxter Springs—The Great Western Mining Co. plans to install an engine and boilers in its proposed concentration plant. O. F. Renegar, Supt.

Kan., Cheney—The city will soon award the contract for the erection of an electric transmission line from here to the line of the Tri-County Light and Power Co.

Kan., Moran—The city plans to install an engine and generating set in its waterworks plant.

Kan., Woodston—F. Shutte has organized a company with $10,000 capital stock and plans to build an electric light plant.

Wyo., Riverton—The Teton Hotel Co. plans to install heating and power equipment in new hotel which will be erected on Main and 3rd Sts.

Ark., Gregory—The Gregory Gin Co., recently organized, is in the market for power plant and cotton ginning machinery. Estimated cost, $8000. W. N. Gregory, J. D. Eldridge and R. T. Harvulle, incorporators.

Ark., Rogers—The Link Pat Mining Co. will build a concentration plant and stamp mill here, and install boilers, motors, compressors, etc., in same. Estimated cost, $100,000. P. C. Quinn, 530 Main St., Joplin, Mo., Supt.

Tex., Orange—The Orange Ice, Light and Water Co. plans to install a new 750 kw. generator and turbine and other machinery for its electric light and water plant. E. M. Vaden, Orange, Ch. Engr.

Tex., Sabinal—C. A. Lindsey, 201 Exchange Bldg., Kansas City, Mo., plans to build a water and storage system near here to include a dam, a hydro-electric power plant and transmission lines. Estimated cost, $3,000,000.

Okla., Miami—The Buckshot Mining Co. will build a concentration plant at Hockerville and install conveyors, engines, boilers, etc., in same. Estimated cost, $60,000. R. E. Brooke, Supt.

Okla., Miami—The Indian Chief Mining Co. will build a concentration plant near here and install belts, boilers, engines, etc., in same. Estimated cost, $75,000. J. L. Sullivan, Supt.

Okla., Oklahoma—The United Development Co. plans to install an engine and boilers in its new concentration plant.

Okla., Peoria—The Dallas-Miami Mining Co. will build a concentration plant near here. Equipment including boilers, engine, compressors, motors, belts, etc., will be installed in same. Estimated cost, $65,000. A. J. Herrington, Carterville, Mo., Mgr.

Okla., Picher—The Commonwealth Zinc and Lead Co., Joplin, Mo., will rebuild its concentration plant which was recently destroyed by fire. New equipment including boilers, engines, belts and conveyors, will be installed. Estimated cost, $100,000. L. N. Dana, Joplin, Mo., Supt.

Colo., Sterling—The Colorado Power Co. purchased a 5 acre site near here and plans to build a new power plant. Estimated cost, $150,000.

Utah, Richfield—S. G. Clark, Sevier, co. clk., will soon award the contract for the erection of a heating plant building and for the installation of a heating plant in the county court house.

Ariz., Florence—B. Macrendy, Searchlight, Nev., has applied for a franchise to build and operate an electric lighting plant here.

Wash., Wenatchee—The Chelan Falls Power Co. plans to erect an electric transmission line in Chelan Co.

N. S., Truro—The Town plans to install an electric lighting plant here. Estimated cost, $40,000.

Ont., Elmira—The Elmira Machinery and Transmission Co., Church St., plans to build an addition to its plant. Estimated cost, $60,000. E. Vice, Mgr.

Ont., Windsor—The Essex Border Utilities Comn. will soon award the contract for furnishing and testing 3 motor-driven pumping units, one having a normal rating of 500 Imperial gal. per minute and 2 having a normal rating of 1000 Imperial gal. per minute.

CONTRACTS AWARDED

R. I., Newport—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for an ice machine and refrigerating plant, to Vilter Manufacturing Co., 910 Clinton St., Milwaukee, Wis. Estimated cost, $39,387.

N. Y., Central Islip—The State Hospital Comn., Albany, has awarded the contract for the installation of the heating system at the Central Islip State Hospital, to W. B. Armstrong Co., Fulton St., Albany, $26,588; installation of boilers, to Babcock & Wilcox, 85 Liberty St., New York City, $66,933. Noted June 18.

N. Y., Ward's Island—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received low bid installing boilers here, from Heine Safety Boiler Co., 11 Bway., New York City, $42,800.

N. J., Newark—The Nucoa Butter Co., 4th St., has awarded the contract for the erection of a 100 x 100 ft. concrete power plant to the American Concrete Steel Co., 31 Clinton St. Estimated cost, $40,000.

D. C. Langdon—The Corby Co. has awarded the contract for the erection of a new boiler works at its works here, to F. L. Wagner, 1413 H St., N. W., Washington.

Wash., D. C.—Bids were received by the Bureau of Supplies and Accounts, Navy Dept., for furnishing equipment as follows:

Schedule 4704¾, Class 397 (Item 1.) Three 15 hp. electric motors, from General Electric Co., River Rd., Schenectady, N. Y., $1095; Wagner Electric Mfg. Co., 6400 Plymouth St., St. Louis, Mo., $1205; Fidelity Electric Co., Lancaster, Pa., $1270; Century Electric Co., 19th and Pine Sts., St. Louis, Mo., $1272; Bell Electric Motor Co., Garwood, N. J., $1587; Reliance Electric & Engineering Co., 90 West St., New York City; $1638; Allis Chalmers Mfg. Co., West Allis St., Milwaukee, Wis., $1790; Robbins & Meyer Co., Lagonda Ave. and Farlow St., Springfield, O., $1834; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $1827.

Schedule 4738¾ (Item 1) 10 turbo generating sets and 200 k.v.a., from Westinghouse Electric & Manufacturing Co., 165 Bway., New York City, N. Y., $6920; Moore, Stem Turbine Corp., 832 Real Estate Trust Bldg., Philadelphia, Pa., $8137; Kerr Turbine Co., 30 Church St., New York City N. Y., $8449; General Electric Co., River Rd., Schenectady, N. Y., $9250. De Laval Steam Turbine Co., North Clinton St. and Pennsylvania R. R., $9444.

Schedule 4656¾, Class 325 (Item 1) 2 motors, from Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $750; Eck Dynamo & Motor Co., Main St., Belleville, N. J., $765; Electric Dynamo Co., Ave. A., Bayonne, N. J., $782; Tompkins Stoddard, 136 Federal St., Boston, Mass., $803; Diehl Mfg. Co., Trumball St., Elizabeth, N. J., $815; Roth Bros., 1400 North Adams St., Chicago, Ill., $867; Robbins & Meyer Co., Lagonda Ave. and Farlow St., Springfield, O., $868; Allis Chalmers Mfg. Co., West Allis St., Milwaukee, Wis., $1040; Reliance Electric & Engineering Co., 90 West St., New York City, N. Y., $1187; General Electric Co., River Rd., Schenectady, N. Y., $1225.

D. C., Washington—The Bureau of Yards and Docks, Navy Dept., received low bids for power plant improvement at the navy yard, here, from Gillis & Gehagen, 537 West Bway., New York City, $44,806, 120 days; Premier Eng. Co., 107 West 13th St., New York City, $45,779, 150 days; W. G. Cornell Co., 923 12th St., $48,884, 120 days.

Ohio, Columbus—I. Littell, brig. genl., War Dept., Wash., D. C., has awarded the contract for the installation of plumbing and heating systems in 21 barracks and 6 warehouses at the War Depot east of here, to S. A. Esswein Plumbing & Heating Co., 96 West Broad St.

Ill., Chicago—The Symington-Starrett Co., 122 South Michigan Ave., has awarded the contract for the erection of a power house in connection with an ammunition plant which will be erected on 74th and Ashland St., to Thompson-Starrett Co., 175 West Jackson St.

Mo., St. Joseph—The St. Joseph Railway, Light, Heat and Power Co. is building a new substation on Felix St. between 2nd and Main St. Estimated cost, $4000.

Calif., Bishop—The Nevada & California Power Co., Riverside, has awarded the contract for the construction of a 55 mi. transmission line and a 14 mi. telephone line, to F. L. Somers, Pomona. Estimated cost, $70,000.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current
Buckwheat	$3.40
Rice	2.90
Boiler	2.65
Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocohontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual
Pea	$5.20	$5.95
Buckwheat	5.15	5.90
Rice	4.65	5.10
Barley	4.15	4.30
Boiler	4.60	....
Broken	6.75	7.50
Egg	6.35	7.10
Stove	6.60	7.35
Chestnut	6.70	7.45

Quotations for domestic coals at the upper ports are 5c. higher on account of the difference in freight rates. Prices for buckwheat, rice, barley and boiler are not fixed by the Government.

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b., Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports are 5c. higher on account of the difference in freight rates.

The foregoing prices ar exclusive of the 3 per cent. war freight tax on both anthracite and bituminous.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line Current	Line One Yr. Ago	Tide Current	Tide One Yr. Ago
Pea	$3.45	$3.10	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.25-2.50
2-in. lump	2.55-2.90	2.55-2.70	2.25-2.50
Steam egg	....	....	2.25-2.50
Mine-run	2.35-2.50	2.35-2.50	1.90-2.10
No. 1 nut	2.55-2.90	2.55-2.70	....
2-in. screen	2.05-2.20	2.05-2.20	....
No. 5 washed	2.05-2.20	2.05-2.20	1.30-1.75

Williamson-Franklin rate to St. Louis is $1.10, other rates, $0.95.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam	$2.50	$2.80	$2.20
Cahaba, Black Creek, Blackwood, Blue Creek	3.20	3.45	2.80
Pratt, Jaeger, Jefferson, Nickel Plate	2.70	3.00	2.40
Corona	2.75	3.10	2.40

The above are Government prices per net ton of 2000 lb. mines and include the 45c. per ton allowed by the wage agreement, less 10c. reduction which was effective May 25, as a result of the agreement with the railroad administration for furnishing fuel coal.